

Exits from Recessions: The U.S. Experience 1920-2011[†]

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Abstract

In this paper we provide some evidence on the issue of when a central bank should shift from expansionary to contractionary monetary policy after a recession has ended—the exit strategy. We examine the relationship between the timing of changes in several instruments of monetary policy and the timing of changes of selected real macro aggregates and price level (inflation) variables across 14 U.S. business cycles from 1920-2007.

We find, based on historical narratives, descriptive evidence and econometric analysis, that in the 1920s and the 1950s the Fed would generally tighten when the price level turned up. By contrast, since 1960 the Fed has generally tightened when unemployment peaked and this tightening often occurred after inflation began to rise. The Fed is often too late to prevent inflation.

1. Introduction

The recession of 2007-2009 has been over for two years and the U.S. economy is recovering, albeit slowly. Real GDP has grown unevenly by on average 2.4% per year since the end of the recession. Monetary policy has been very expansionary since the fall of 2008 (as has fiscal policy). The Federal Reserve reduced the funds rate from 5.25% in August 2007 to close to zero by January 2009 and since hitting the zero nominal bound it followed two rounds of quantitative easing—the purchase of long-term Treasuries and mortgage backed securities-- which ended in June 2011. The question now arises over how to return its policy to one consistent with long-run growth and low inflation—the exit strategy. To do this involves switching from expansionary to a neutral monetary policy, reducing the Fed's balance sheet and for fiscal policy, reducing the large fiscal deficits and increases in the national debt.

The key question is when should this happen. There have been two views on this subject. One view argues that because of the financial crisis, the credit crunch, the housing bust, and the large overhang of nonperforming loans and toxic assets that the recovery will be slow and that the need to tighten will be protracted. This view is backed up by cross country evidence which demonstrates that recessions accompanied by financial turmoil tend to be deeper and longer (Claessens et al 2008, Reinhart and Rogoff 2009). The alternative preferred view was that the recovery would be V shaped as was the case in

most of the severe recessions in the U.S. in the twentieth century (Mussa 2009). However after two years this seems not to have been the case.

The risks facing monetary policy with respect to the exit strategy are twofold: tightening too soon and creating a double dip recession and tightening too late leading to a run up of inflation. There are a number of famous historical examples of each type of error. Tightening too soon after the Great Contraction led to the recession of 1937-38. Tightening too late in the recessions of the 1960s and 1970s contributed to the Great Inflation.

In this paper we provide some evidence for this issue by examining the historical record of U.S. business cycles from 1920 to the last full cycle which peaked in December 2007. Our approach is to first provide a brief historical narrative on each of the cycles. (Section 2) . We then present descriptive evidence in section 3 on the timing of policy change from ease to tightness and on the changes of macro aggregates around the lower NBER turning point of each cycle. We divide the sample in two: cycles before World War II from 1920 to 1938; and cycles from 1948 to the present.

To supplement the descriptive analysis we estimate in section 4 a simple reaction function for the Fed where the changes in the federal funds rate are related to changes in unemployment, inflation and the output gap. In section 5 we use the coefficients of the effects of the timing of the indicator in the postwar period to predict the possible exits from the current recession. Section 6 concludes.

We can discern some basic patterns across the historical experience. In general in the post WWII period the Fed tends to tighten when inflation (the price level) is rising and postpones tightening when the output gap and unemployment have yet to turn. However the decision to wait until unemployment (the output gap) turns, dominates the decision to tighten when inflation rises. The timing of tightening differed somewhat before and after World War II. In the pre WWII era the Fed would generally tighten when the price level turned up. This could cause it to tighten too soon. In the post WWII era the Fed, by focusing on unemployment tended to err on the side of tightening too late, i.e. after inflation resurged.

We also find that there are a few cycles when the Fed got the timing just right and followed a countercyclical policy.¹ These were in the 1920s and 1950s as earlier discussed by Friedman and Schwartz (1963) and Meltzer (2003, 2010). In most cycles Fed actions were procyclical.

We further note a significant difference between the cycles before 1965 when the Fed adhered to some form of gold standard convertibility rule and the Fed attached highest priority to price stability (Bordo and Eichengreen 2009) and the cycles since when the gold standard became a less important consideration and then did not matter at all. In the late 1960s and 1970s, the Fed generally waited until unemployment and the output gap declined before tightening and placed little emphasis on the pace of inflation. Since the

¹ Friedman (1953) was the first to analyze the difficulty of achieving the pace and timing for successful countercyclical policy.

Volcker shock in the early 1980s, the Fed has placed more emphasis on reducing inflation than before in determining its exit strategy. A memorable episode in which the Fed tightened when unemployment was high and rising was in 1981 when Volcker was determined to break the back of inflation.

In the last two cycles, in the early 1990s and early 2000s the Fed, concerned with persistent unemployment (“a jobless recovery”), waited too long. In the first case, significant tightening occurred close to three years after the trough following “the inflation scare of 1994”. In the second case, the Fed, concerned with the risk of deflation, waited four years after the trough and accordingly may have ignited the housing price boom which burst in 2006 leading to the recent recession. The recent episode with unemployment at over 10 per cent and low inflation seems to be similar to the two preceding cycles.

2. Historical Narrative: 1920-38

2.1. Peak January 1920, Trough July 1921. The recession of 1920-21 was one of the three worst recessions of the twentieth century. Friedman and Schwartz (1963) viewed it as the Fed’s first policy failure. They indict the Fed for waiting too long to raise rates to stem the inflationary boom that followed World War I and then for waiting too long to reverse the ensuing recession. The Fed waited until November 1919 to begin tightening because of pressure by the Treasury on the Fed to keep the prices of its wartime bond issues high. During the recession that followed, real GNP fell by 15%, industrial

production fell by 23%, the GNP deflator fell by 20% and the unemployment rate increased by 8%.

The cause of the recession was the Fed's decision (triggered by a decline in its gold reserves), to implement a very rapid deflation, to roll back the run up in prices that had occurred since the U.S. entered World War I. The Fed raised the discount rate from 4 3/4% in January 1920 to 7% in June and kept it at that level until May 1921. The highly persistent rise in nominal interest rates in the face of a shift in expectations from inflation to deflation represented a much tighter policy stance than agents anticipated (Bordo, Erceg, Levin and Michaels 2007). In the face of mounting political pressure the Fed reversed course four months after the recession ended. IP recovered in August and by March 1922 had increased 20% above the previous year.

2.2 Peak May 1923, Trough July 1924. The recession of 1923-24 was relatively brief and by pre World War II standards mild, real GNP fell by 4%. The recession followed a tightening of monetary policy beginning in May 1922 which reflected concern that the rapid recovery from the previous recession was becoming inflationary. In contrast to the previous recession the Fed began reversing course soon after the recession became apparent in December 1923 with open market operations and then cuts in the discount rate in May 1924 (Meltzer 2003). Friedman and Schwartz gave the Fed high marks for conducting a successful countercyclical policy.

2.3. Peak October 1926, Trough November 1927. Similar to the recession of 1923-24, the Fed began tightening, reflecting fears of inflation, in January 1925 with open market sales and then a rise in the discount rate in February. As in the preceding recession, the Fed reversed course and began open market purchases in May 1927, halfway through the mild recession (Meltzer 2003).

2.4. Peak August 1929, Trough March 1933. The Great Contraction of 1929-33 during which prices, real GNP and the money stock (M2) declined by about a third, was the worst recession in U.S. history. Since Friedman and Schwartz (1963), it is widely attributed to policy failures at the Federal Reserve. Beginning in 1927 the Federal Reserve Board became increasingly concerned over stock market speculation and the growing boom on Wall Street. Based on the real bills doctrine many officials believed that stock market speculation was inflationary. The Fed began monetary restraint with open market sales in February 1928 and continued this policy through 1929 with a rise in the discount rate from 5% to 6% in August 1929.

The tightening while insufficient to halt the stock market boom was sufficient to induce a downturn beginning in August 1929. The Stock Market Crash in October 1929 exacerbated the downturn but did not cause the depression. The failure of the Fed to follow its mandate from the Federal Reserve Act of 1913 to act as a lender of last resort and to allay a series of four banking panics beginning in October 1930, led to the serious downturn that followed. A major hike in the discount rate in October 1931 to protect the dollar after sterling exited from the gold standard added fuel to the fire. Despite short

lived expansionary open market purchases in the spring of 1932 which if continued could have ended the recession (Friedman and Schwartz) the recovery in March 1933 was not precipitated by Fed policy.

Recovery began in March 1933 with Roosevelt's banking holiday, ending the fourth banking panic. The nation's banks were closed for a week during which an army of bank inspectors separated the insolvent banks from the rest. Insolvent banks were closed ending the uncertainty driving the panic. This action was quickly followed by FDR taking the U.S. off the gold standard in April, Treasury gold (and Silver) purchases designed to raise gold prices and prices in general, and formal devaluation of the dollar by close to 60% in January 1934. These policies produced a big reflationary impulse from gold inflows which were unsterilized passing directly into the money supply. They also helped convert deflationary expectations into inflationary ones (Eggertsson 2008).

The recovery of 1933 to 1941 was largely driven by gold inflows (initially reflecting Treasury policies and the devaluation, later reflecting capital flight from Europe as war loomed. Expansionary fiscal policy played only a minor role in the recovery of the 1930s (Romer 1992). Recovery was impeded somewhat by New Deal cartelization policies like the NIRA which in an attempt to raise wages and prices artificially reduced labor supply and aggregate supply (Cole and Ohanian 2004). Over the period 1933-37 output increased by 33%.

2.5 Peak May 1937, Trough June 1938. The 1937-38 recession, which cut short the rapid recovery from the Great Contraction of 1929-33, was the third worst recession in the twentieth century: real GNP declined by 10% and unemployment which had declined considerably after 1933 increased to 20%. The recession was primarily a consequence of a serious policy mistake by the Federal Reserve. Mounting concern by the Fed over the inflationary consequences of the build up in excess reserves in member banks (held as a precaution against a repeat of the banking panics of the early 1930s), led the Board to double reserve requirements in three steps between August 1936 and May 1937. Fed officials were concerned that these reserves would lead to an explosion of lending and would foster a reoccurrence of the asset price speculation of the 1920s. They also believed that reducing excess reserves would encourage member banks to borrow at the discount window. The Burgess—Riefler doctrine which prevailed at the time argued that the Fed could exert monetary control by using open market operations to affect member bank borrowing and hence to alter bank lending (Meltzer 2003).

The consequence of doubling reserve requirements in three steps from August 1936 to April 1937 was that banks sold off their earning assets and cut their lending to restore their desired cushion of precautionary reserves. The Fed's contractionary policy action was complemented by the Treasury's decision in late 1936 to sterilize gold inflows in order to reduce excess reserves. These policy actions led to a spike in short-term interest rates and a severe decline in money supply.

The recession ended after FDR in April 1938 pressured the Fed to roll back reserve requirements, the Treasury stopped sterilizing gold inflows and desterilized all the remaining gold sterilized since December 1936 and the Administration began pursuing expansionary fiscal policy. The recovery from 1938 to 1942 was spectacular; output grew by 49% fueled by gold inflows from Europe and a major defense build up.

Historical Narrative: 1948-2007

2.6 Peak November 1948, Trough October 1949. After the war, inflation increased to 15% per year by 1948. Tightening by both the Treasury and the Fed began in October 1947. A mild recession ensued beginning in November 1948. Real GNP fell by less than 2 %, IP by 9% and CPI prices fell by 2%. Fed policy was slow to change during the recession because the Fed viewed low nominal interest rates (T bills) at close to 1% as evidence of ease and didn't realize that in the face of recession real rates were elevated. The Board reduced reserve requirements by 2% in May 1949. According to Meltzer (2003, chapter 7), 1948-1949 was similar to 1920-21 in that deflation by both encouraging gold inflows and increasing the real value of the monetary base helped to re-inflate the economy.

2.7 Peak July 1953, Trough May 1954. After the Federal Reserve Treasury Accord of March 1951, the Fed was free again to use its policy rates to pursue its policy aims. One of the first occasions was at the end of the Korean War when both monetary and fiscal policy tightened to prevent an increase in inflation. In January 1953 the Fed raised its

discount rate and the real money base declined leading to a recession beginning in July. The real economy declined by 3.2%, IP by 9.4% and unemployment rose to 6.1%. However unlike earlier recessions the Fed eased policy in June 1953 to offset a spike in long-term Treasury bond rates. Ease continued with a decline in reserve requirements in July 1953 and a decline in the discount rate in February, April and May 1954 and declines in reserve requirements in June and July. By October 1954 with recovery well underway the Fed began to tighten in December in the face of incipient inflationary pressure. The Fed raised the discount rate in 7 steps from the end of 1954 to 1957. This was evident in a rise in ex post interest rates (Meltzer 2010 chapter 2, Friedman and Schwartz 1963 chapter 11).

2.8 Peak August 1957, Trough April 1958. Growing concern over the pace of recovery from the previous recession and a run up in inflation in 1955 led the Fed to begin tightening in April by raising the discount rate. Further increases followed in 1956. The ensuing recession was relatively mild with real GDP falling by 3% and unemployment rising to 7.5%. The Fed was slow to respond to the recession because of continuing concern over inflation (Meltzer 2010 chapter 2). It began easing in November 1957 by reducing the discount rate and reserve requirements and conducting open market purchases in March and April 1958. The recovery was vigorous and the Fed again worried about inflation began tightening (raising the discount rate) in August, four months after the trough. It was also concerned for the first time in the postwar period with gold outflows (Friedman and Schwartz 1963 page 618).

2.9 Peak April 1960, Trough February 1961. The Fed began tightening in the spring of 1959 in the face of rising inflation and gold outflows. By early 1960 the FOMC recognized that the economy had slowed and began to ease two months before the April business cycle peak, as it had done in 1953. The ensuing recession was mild and lasted 10 months. Real GNP fell by less than 1% and unemployment increased to 7%. Fed policy continued to be loose throughout the downturn, the discount rate was cut in March and August and reserve requirements were cut in August. The recession ended in February. After the trough the policy directive for ease was moderated in April (Meltzer 2010 chapter 3). The real federal funds rate began to rise one quarter after the trough and the growth of the real base slowed at the trough. Unemployment peaked in May.

2.10 Peak November 1969, Trough November 1970. The period from 1961 to 1964 exhibited very rapid growth with low inflation. Inflation began to rise in 1965. The Fed tightened in December 1965 against President Johnson's wishes but not enough to stem rising inflation. Further tightening in the spring and summer of 1966 led to the "Credit Crunch" of 1966, a growth slowdown but not a recession (Bordo and Haubrich 2009). The Fed began tightening again in the summer of 1969 seen in a decline in real base growth and a rise in real interest rates leading to a mild recession which began in July 1969. Real GNP fell less than half a percent, unemployment increased to 5.9% and inflation only slowed moderately. Policy began to ease after January 1970 seen in a flattening of real base growth.

In April 1970 Chairman Arthur Burns abandoned the anti-inflationary policy that had been pursued by his predecessor William McChesney Martin because of the slowing economy. By June 1970 real base growth was positive and real interest rates declined. The easy policies continued until after the trough. Recovery in real GNP was relatively sluggish and unemployment didn't peak until the summer of 1971. Policy shifted to less ease after the trough seen in a rise in the real funds rate and a flattening of real growth. This recession was the first during the Great Inflation episode in which the Fed revealed its unwillingness to stem inflation at the expense of unemployment (Meltzer 2010 chapter 3).

2.11 Peak November 1973, Trough March 1975. The Nixon administration imposed wage price controls in August 1971 to fight unemployment but the policy was unsuccessful. CPI inflation increased to 10% by 1974. In the face of rising inflation from December to August 1972, the Fed tightened but not enough (Meltzer 2010 chapter 6). Further tightening occurred in the summer of 1973 seen in a decline in real base growth. The recession which began in November was one of the worst in the postwar, real GNP declined by 4.7%, unemployment increased to 8.6%. The recession was greatly aggravated by the first oil price shock which doubled the price of oil and by the price controls which prevented the necessary adjustment. Beginning in July 1974 the Fed shifted to easier policy in the face of rising unemployment seen in a reversal in the federal funds rate (both nominal and real). Monetary ease continued in the first quarter of 1975 when the Fed cut the funds rate, the discount rate and reserve requirements. The recovery began in April 1975 but according to Meltzer (2010 chapter 7) the Fed did not

recognize it until August. The Fed, still concerned with inflation began increasing the funds rate in the quarter after the recession ended and real base growth flattened in the same quarter.

2.12 Peak January 1980, Trough July 1980. By 1979 inflation had reached double digit levels. In August 1979 President Carter appointed a well known “inflation hawk” Paul Volcker, as Chairman of the Federal Reserve. Two months after taking office, Volcker announced a major shift in policy aimed at rapidly lowering the inflation rate. He desired the policy change to be interpreted as a decisive break from past policies that had allowed the run up in inflation. The announcement was followed by a series of sizable hikes in the federal funds rate. The roughly 7 percentage point rise in the nominal funds rate between October 1979 and April 1980 was the largest increase over a six month period in the history of the Federal Reserve System. The tight monetary stance was temporarily abandoned in mid 1980 as interest rates spiked and economic activity decelerated sharply. The FOMC then imposed credit controls (March to July 1980) and let the funds rate decline—moves that the Carter administration had politically supported. The controls led to a marked decline in consumer credit, personal consumption and a very sharp decline in economic activity (unemployment increased from 6.3 to 7.5%). In July 1980 the Fed shifted to an expansionary monetary policy seen in cuts in the federal funds rate and increases in real base growth. The recession ended in July 1980 followed by a very rapid recovery. Fed policy started to tighten again in May 1981 in the face of a jump in inflation seen in a sharp reversal in real base growth and then successive rises in the discount rate beginning in September .The FOMC policy reversal and acquiescence to

political pressure in 1980 was widely viewed as a signal that it was not committed to achieving a sustained fall in inflation. Having failed to convince price and wage setters that inflation was going to fall the GDP deflator rose almost 10% in 1980.

2.13 Peak July 1981, Trough November 1982. The Fed embarked on a new round of tightening in the spring of 1981. It raised the federal funds rate from 14.7% in March to 19.1% in June. This second and more durable round of tightening succeeded in reducing the inflation rate from about 10% in early 1981 to about 4% in 1983, but at the cost of a sharp and very prolonged recession. Real GNP fell by close to 5% and unemployment increased from 7.2% to 10.8%. The Fed's tightening during a recession was initially supported by both President Reagan and Congress. However by the spring of 1982 the Fed faced increasing pressure from the Congress and the Administration to loosen policy. There was also concern over the solvency of the money center banks hit by the Latin American debt defaults and over the effects of high interest rates on other countries. The Fed shifted to a looser policy in June 1982 with a decline in the discount rate and the federal funds rate and a rise in the growth rate of the real monetary base. After the trough real output, the output gap and IP rose rapidly. Unemployment peaked quickly. Policy tightened somewhat in terms of both the real funds rate and the real base soon after the trough reflecting the FOMC's determination to continue to reduce inflation (Meltzer 2010 chapter 8).

2.14 Peak July 1990, Trough March 1991. The recession of 1991 was preceded by Fed tightening beginning in December 1988 (Romer and Romer 1994). The FOMC wanted to

reduce inflation from the 4-4.5% range. The federal funds rate rose from 6 1/2 % to 9 7/8 % between March 1988 and May 1989. The recession began in July 1990 and was aggravated by an oil price shock after Iraq invaded Kuwait in August 1990. The recession was mild. Real GNP fell by only 1.4%. The FOMC only began cutting the federal funds rate in November because its primary concern was to reduce inflation which had reached 6.1% in the first half of 1990 (Hetzel 2008 chapter 15).

The recovery from the trough in March 1991 was considered tepid (real output grew at 3.6% for the 3 years following the trough compared to the postwar average of 5 %) and it was referred to as a jobless recovery—unemployment peaked at 7.7% in June 1992. The recession is also viewed as a credit crunch (Bernanke and Lown 1991). Evidence in Bordo and Haubrich (2009) and the IMF WEO 2008 suggests that recessions tend to last longer which involve credit events. The funds rate declined until October 1992. Inflation began to pick up in the first quarter of 1993 and by early 1994 the Fed shifted to a tighter policy, “the inflation scare of 1994” (Hetzel 2008, chapter 15, page 202.)

2.15 Peak March 2001, Trough November 2001. In 2000 the Fed loosened monetary policy because of the fear of Y2K. The tech boom which had elevated the NASDAQ to unsustainable levels burst leading to a decline in wealth and in consumption. The FOMC didn't forecast a recession and was slow to respond because of tightness in the labor market (Hetzel 2008, page 241). Although real growth began decelerating in mid 2000, the FOMC began reducing the funds rate in January 2001 and lowered the rate from 6.5 to 1% by June 2003. Real short-term rates fell from 5% mid 2001 to 0 mid 2002 but not

rapidly enough to prevent policy from being contractionary (ibid page 242). After the trough, in November although real growth had picked up, employment had not and like the previous recession there was talk about a jobless recovery. By March 2004 the unemployment rate at 5.7% was still near its cyclical peak. Moreover the Fed worried about deflation and the zero lower bound problem in 2003. Consequently the funds rate was maintained at its recession low until June 2004 when alarmed by an increase in inflationary expectations the Fed began raising the funds rate at 0.25% increments until late summer 2007.

2.16 Peak December 2007, Trough June 2009 The recent recession is familiar in some respects and novel in others. It is familiar in the sense that the recession although somewhat longer in duration and somewhat deeper than the postwar average is within the realm of the postwar experience. It is novel in the sense that it was precipitated by a financial crisis consequent on the end of a major housing boom. It has been argued by many that a key contributing factor (along with lax regulatory oversight and a relaxation of normal standards of prudent lending) to the asset boom was an extended period of loose monetary policy from 2002-2004 in reaction to slow employment growth, fears of incipient crises and deflation. Contributing factors to the asset bust include a return to tighter monetary policy in 2005, the collapse of the subprime mortgage market and of the securitization model by which derivatives including toxic mortgages were bundled. The severity of the resultant recession from December 2007 to the summer of 2009 reflected both a credit crunch and tight Federal Reserve policies (seen in high real federal funds rates) in 2008 (Hetzl 2009). The recession is in some respects the most severe event in

the postwar period (real GDP declined by close to 4% and unemployment has so far reached 10.2% and the financial crisis is without doubt the most serious event since the Great Depression (the BAA long term Treasury quality spread increased by 342 basis points by April 2009 which was higher than in 1929-33).

Both the crisis and the recession were dealt with by vigorous policy responses (expansionary monetary policy cutting the funds rate from 5.25% in early fall 2007 to close to zero by January 2009 and a massive fiscal stimulus package); and by unorthodox quantitative easing (the purchase of mortgage backed securities and long-term Treasuries since January 2009;and an extensive network of facilities(such as the TAF) created to support the credit market directly and reduce spreads involving a tripling of the Fed's balance sheet. The first two years of the recovery was tepid and halting, with growth of 2.4% on average and unemployment above 9%, monetary ease has continued for two years and the exit strategy is not yet in place. In section 5 we use our econometric analysis to give a “guesstimate” on when tightening will occur.

3. Descriptive Evidence

3.1 Introduction

For all the business cycles since 1920 (excluding the two cycles which bracketed World War II) we ascertained the turning points in the quarterly values of several policy variables: before 1954 the discount rate (nominal and real); since 1954 the federal funds

rate (nominal and real); the growth rate of the monetary base (nominal and real); the growth rate of M2 (nominal and real). We did the same for several real macro-aggregates: real GNP, industrial production, the unemployment rate, the output gap based on an HP filter, and two measures of the price level and inflation (the GNP deflator and the CPI).² For data sources and definitions see Appendix Table A.1.

In the period before 1960 when inflation was generally low and the U.S. adhered to some form of the gold standard (under which prices are mean reverting) we focus on the price level as a policy target. Since 1960 inflation has been continuously positive so we focus on measures of inflation as our policy target.

3.2 Determining the Turning Points

The turning points of each of the series, reported in Tables 1 and 2 below were determined as follows: For each of the macroeconomic aggregate variables (two measures of the price level and inflation, real output, industrial production, the output gap and unemployment) the date at which the variable started to improve after the start of the recession was chosen by visual inspection of the time series figures for each variable as shown in the Appendix.

² The Fed did not have GNP or unemployment data during the interwar period (these data were constructed after World War II). Moreover they did not think about recessions in terms of output gaps. They did however have data on industrial production. Nevertheless we use the available modern data on GNP and unemployment to make comparisons between the post world war II era and the interwar.

For the price level and inflation this was the first date after the start of the recession when the price level or inflation rate changes from having a negative slope to a positive slope. Similarly for real output, industrial production and the output gap we looked for the first quarter after the start of the recession in which the slope of the series changed from being negative to positive. The rule for unemployment was the opposite with the turning point being the first quarter after the start of the recession in which the derivative of the unemployment series changes from positive to negative.

For the policy variables the decision rule was to look for the first period in which there is evidence of monetary tightening. For the various interest rate series this meant looking for the first quarter after the start of the recession where interest rates started to increase from a period of falling or relatively level rates. For the monetary aggregate growth variables we looked for the first quarter after the start of the recession where the aggregates growth rates started to fall from a time of increasing growth rates or relatively constant growth rates.

Obviously this approach of visual inspection is a subjective approach to selecting turning points of time series but in almost all cases there was a clear cut choice. In some cases there seemed to be multiple periods close together that could be considered a turning point of a series. In these cases we made sure to pick a turning point where there was at least two quarters each side of the turning point where the time series was either always above or always below the level of the series at the turning point depending on the type of series being inspected. In the rare cases where there were multiple turning points

which did not meet these criteria we chose the turning point that was the highest or lowest point depending on the type of series being inspected. In the case of the policy variables, if there was any doubt about the turning point, we chose the turning point closest to the date of the turning point inferred by our reading of the historical narratives in Section 2 above.

3.3 Descriptive Evidence

We present the series used in a series of figures in the Appendix. Appendix Table A.2 displays the dates of the turning points. In Tables 1 and 2 we then present the timing of turning points as the number of quarters deviation from the NBER trough (A minus sign indicates number of quarters before the trough.)

Table 1 shows the timing of the turning points relative to the NBER trough of the policy variables and the macro aggregates for each cycle in the pre World War II period (1920-1938). Table 2 shows the timing of the turning points relative to the NBER trough from the cycles from 1948 to 2007. In both tables we also show the timing of tightening as can be discerned from the historical narratives in Section 2 above.

3.4 Pre World War II: 1920-1937

In this narrative we briefly describe the salient patterns of the policy indicators and the real aggregates and prices.

3.2.1 1920Q1-1923 Q1, Trough 1921 Q3. In this cycle, the official discount rate tightened well after the trough and after the real aggregates, and after the price level turned up. Policy measured by the growth in the real monetary base and by real M2 also tightened after the NBER trough and after the real aggregates (real GNP, IP, the output gap and unemployment) turned but before the price level increased. Thus in this cycle, policy measured by real base growth was relatively well timed to prevent rising prices but measured by the discount rate the Fed was too late.

3.2.2 1923Q2- 1926Q2, Trough 1924 Q3. In this cycle, monetary policy (both the official discount rate and the real rate in addition to real base growth) tightened after the real economy turned up and after the price level turned up. This suggests that policy was too late to prevent prices from rising

3.2.3 1926Q3-1929Q2, Trough 1927 Q4. Monetary policy (with the exception of base growth) tightened when the real economy turned up and before the CPI price level (but after the GNP deflator) turned. This suggests that policy was more or less on time.

3.2.4 1929Q3-1937Q1, Trough 1933Q1. The Great Contraction ended in March 1933. Policy tightened long after recovery began based on the monetary aggregates. The Fed rarely changed its policy rates from 1934 -1951 during most of which period it was subservient to the Treasury and was committed to maintaining a low interest rate peg. This suggests that the nominal discount rate is not a good measure of the stance of policy.

Significant tightening after this trough occurred in 1936 according to the narratives when the Fed began doubling reserve requirements (although the monetary aggregates in Table 1 showed minor slowdowns in 1933-34). The doubling of reserve requirements occurred after real economic activity, and prices turned up but well before output reached full capacity and while unemployment was still high. This episode is generally viewed as one where policy tightened too soon.

3.5 Post World War II 1948-2007

We omitted two cycles from the analysis containing the war years. In these cycles from 1937Q2-1944Q4, Trough 1938 Q2 and from 1945 Q1-1948 Q3, Trough 1945 Q4 the timing of monetary policy changes seemed unconnected to the business cycle and occurred many years after the troughs. This made it difficult to analyze the timing of the exit from recession comparable to the other peacetime cycles.

3.3.1 1948Q4-1953Q1, Trough 1949Q4. In this first postwar cycle, the discount rate (nominal and real) tightened after the real economy recovered and after inflation (prices) turned up. Real and nominal base growth turned up before the real economy and with CPI and before GNP inflation.

3.3.2 1953Q2-1957Q2, Trough 1954Q2. Monetary policy measured by the federal funds rate (nominal and real) began tightening after real GNP began to recover but when unemployment peaked. Policy tightened after GNP inflation (prices) picked up but before

the CPI. As measured by real base growth, monetary policy was too late for GNP inflation (prices) but just about on time for CPI inflation (prices). This suggests that on average monetary policy was close to being timely.

3.3.3 1957 Q3-1960Q1, Trough 1958 Q2. Monetary Policy measured by the federal funds rate (real and nominal) suggests that tightening occurred after the real economy turned but at the same time as unemployment and the output gap turned and before GNP inflation turned up. By this measure policy was just right. Moreover real base growth turned close to the real economy and before GNP inflation increased. Again as in the preceding cycle the timing of policy was on average close to being just right.

3.3.4 1960Q2-1969Q3, Trough 1961Q1. Policy measured by the federal funds rate (nominal and real) turned up close to or after the real economy recovered. The case is similar for inflation. Real base growth turned up after the real economy troughed and after inflation turned up. This was the cycle in which inflation began to rise persistently as discussed in section 2 above.

3.3.5 1969Q4- 1973Q3, Trough 1970Q4. Policy using both rates and aggregates tightened after the real economy recovered but closer to the turning point in unemployment. Moreover as has been the case in most cycles, policy has been procyclical. In addition, policy using both rates and aggregates tightened after GNP inflation picked up. Monetary policy was clearly too late.

3.3.6 1973Q4-1979Q4, Trough 1975 Q3. Both measures of policy (the real and nominal funds rate and the nominal and real monetary base) tightened approximately when the real economy began to recover and when inflation turned up. However although the Fed timed its exit well, inflation was not substantially reduced.

3.3.7 1980Q1-1981Q2, Trough 1980Q3. In this cycle, both measures of policy tightened close to when the economy began to recover and shortly after GNP inflation picked up. In this episode as mentioned in section 2 above, Fed tightening focusing on monetary aggregates was designed to break the back of inflationary expectations.

3.3.8 1981Q3-1990Q2, Trough 1982Q4. Monetary policy measured by the (real and nominal) federal funds rate tightened about the time the real economy began to recover and when inflation turned up. A similar pattern holds for nominal and real base growth. Thus on average policy was well timed.

3.3.9 1990Q3-2000Q4, Trough 1991Q1. Policy using the funds rate shows that policy tightened after unemployment peaked which was 6 quarters after real activity began recovering. It also tightened after inflation resurged. Using real base growth as a policy measure leads to a similar outcome. Both policy indicators suggest that the Fed was focused on unemployment (the jobless recovery). With respect to stemming inflationary pressure the Fed was too late.

3.3.10 2001 Q1-2007Q3, Trough 2001Q4. Using the nominal funds rate suggests that policy tightened well after GNP recovered and closer to when unemployment began recovering. Both measures tighten long after inflation picks up. These actions suggest that policy tightened too late. The timing of real base growth suggests that the Fed tightened after the real recovery and well before the peak in unemployment but after the turning point in inflation. Using this measure policy was also too late.

3.4. Lessons from the Timing Exercise

3.4.1 The Pre World War II Evidence

The first lesson is that the pre World War II evidence suggests that the Fed was too late in tightening to offset incipient inflation more often than not. However in two episodes (after the recessions of 1921 and 1927) the timing of the policy exit was much better. Second, the verdict on timing often differs between focusing on nominal and real base growth versus the nominal and real discount rates. Meltzer (2003) provides evidence that real base growth is generally more closely lined up with the turning points in the business cycle than is the real discount rate. He also points out that Fed officials did not understand the distinction between nominal and real interest rates.

3.4.2 The Post World War II evidence

The first lesson is that in the post war cycles the descriptive evidence suggests that policy was often too late by one or the other measures to prevent inflation from rising. The Fed generally tightened when unemployment peaked and when the other real indicators troughed at roughly the same time. However the recessions of the 1950s stand out as ones where the exit timing was favorable. Second, during the Great Inflation cycles of the 1960s and 1970s the problem of mistiming the exits was less serious than the unwillingness to tighten sufficiently to stem inflationary pressures. This was not the case after the 1980 recession. Third, in the subsequent Great Moderation period from the mid 1980s to 2007, policy was too late in exiting in the last two cycles in the early 1990s and early 2000s. In each case monetary policy only tightened when unemployment and the output gap declined, long after the recovery of real activity and also after a recovery in inflation. However, the Fed's actions in these cycles may reflect the fact that they felt they had achieved credibility for low inflation after their success in stemming inflationary expectations in the 1980s, hence they felt that they could afford to wait. In the last cycle the Fed was concerned with deflation from 2002-2004 and for that reason was reluctant to tighten. The recent recession with unemployment very high may turn out to be similar in the timing of the exit from monetary ease to the experience of the last two episodes.

Figure 1 summarizes the evidence on tightening in the post WWII cycles. In each sub-figure the vertical axis shows the number of quarters that the two principal "recession" variables (unemployment and inflation) turned before the particular policy variable

tightened. On the horizontal axis of each sub-figure is the year in which the recession ended. A value of 1, for example, means that the “recession” variable turned 1 quarter before the Federal Reserve tightened. A negative number means that the variables turned after the policy variable tightened.

In Figure 1 we report the turning points of unemployment and inflation relative to the tightening dates of five important policy variables: 1) the historical narratives, 2) the nominal Federal Funds rate, 3) the real Federal Funds rate, 4) the growth rate of the nominal money base and 5) the growth rate of the real money base. Except for the recession ending in 1990 the unemployment line is always below the inflation line which implies that, except for that one recession, unemployment always turned after inflation. However the relative position of the turning points to the date of tightening varies by policy variable.

For the historical narratives and the nominal federal funds rate (see the first two sub-figures on the first row of the figure) the lines lie almost always above or on the zero line (the date that the policy variable tightened). According to the historical narratives the Fed tightened after or on the date of the turning point of inflation for all but the recession ending in 1953. In the two recessions that ended in the 1970’s the Federal Reserve tightened before unemployment turned. Other than that the narratives suggest that the Federal Reserve waited for unemployment to turn before tightening monetary policy. The second sub-figure which looks at the nominal Federal Funds rate tells a similar story. The Federal Reserve waited until inflation and unemployment turned before tightening

monetary policy. In one case, the most recent complete recession, the Federal Reserve waited a long time for unemployment to turn before tightening monetary policy. In only one case, the recession ending in 1973 did the Federal Funds rate increase before unemployment turned.

Using the real federal funds rate to identify the tightening date we observe that for the early cycles (i.e. the cycles up until the cycle ending in 1969) the Fed waited for unemployment to turn. During the 1970s the real Federal Funds rate tightened before unemployment and after inflation and again during the last complete post-WWII cycle.

For the other nominal policy variable-the growth rate of the money base- the pattern is not as obvious. It appears that with respect to money base the Fed typically did not wait for unemployment to peak before tightening but still often tightened after inflation turned up. This is most apparent for the last complete post-WWII recession where the tightening occurred 7 quarters before unemployment turned but 1 quarter after inflation turned.

Finally looking at the growth rate of the real money base series the pattern shows some similarity to that of the nominal base but there are two cycles (the cycle ending in 1973 and the cycle ending in 2007) for which the real money base tightened well before unemployment turned. Also policy usually tightened close to when unemployment turned but before inflation turned and tightening for inflation was often closer to the business cycle trough.

In general Figure 1 shows that across the different policy measures, policy typically tightened close to when unemployment peaked and close to but more often after inflation turned up. This was most evident when we used either the tightening dates suggested by the historical narratives or the tightening dates suggested by the key policy variable (the Fed Funds rate). This highlights the conclusion that policy tightening was often too late to prevent inflation rising.

4. Evidence from Estimating a Reaction Function for the Federal Reserve

In this Section we outline results from estimating a simple reaction function for the Fed where changes in the Federal Funds Rate is related to current changes in unemployment, current changes in inflation and an output gap measure. We report results for both a static regression, where all coefficients are constant for the whole sample, and a time varying parameter regression, where the coefficients of the reaction function are allowed to vary over time. We report the results of the various estimations for the post WWII sample where the Fed Funds Rate is available.

The reaction function that is estimated is

$$\Delta r_t = \beta_0 + \beta_1 \Delta \pi_t + \beta_2 (y_t - y_t^*) + \beta_3 \Delta U_t + \varepsilon_t \quad (1)$$

where the inflation rate is the annualized change in the GDP deflator, the output gap is the percentage difference between real GDP and the trend in GDP.³ As a reference and

³ The trend in GDP is computed using the Hodrick-Prescott filter on the logarithm of GDP.

in order to get good starting values for the time-varying parameter model we estimated (1) using least squares for the whole sample from the first quarter of 1955 (1955Q1) until the first quarter of 2011 (2011Q1). The results are reported in (2) below:⁴

$$\Delta r_t = 0.011 + 0.395\Delta\pi_t + 0.002 (y_t - y_t^*) - 1.117\Delta U_t \quad (2)$$

(0.847) (0.000) (0.444) (0.000)

The estimates reported in (2) show, for over the whole period from 1955Q1 to 2011Q1, that current changes in inflation and unemployment enter into the reaction function significantly while the output gap does not.⁵

As this regression is estimated with unchanging parameters over the whole period it is not clear whether this result that the output gap is not important holds for the whole sample or for only a majority of the sample. In order to assess the changing nature, if any, of the strength of the relationship between the three right hand side variables to changes in the policy rate we next estimate a modified version of (1) that allows for the parameters to vary over time. The specific time-varying parameter model we employ is

⁴ The numbers in parentheses are p-values.

⁵ The result that output does not significantly enter the reaction function is robust to different definitions of the output gap and also to using growth rates of output instead of levels. Also, an alternative specification of the reaction function with lagged changes of the Fed Funds Rate was also tried but the coefficient on the lagged interest rate was not significant.

$$\begin{aligned}
\Delta r_t &= \beta_{0t} + \beta_{1t} \Delta \pi_t + \beta_{2t} (y_t - y_t^*) + \beta_{3t} \Delta U_t + \varepsilon_t \\
\beta_{0t} &= \beta_{0t-1} + v_{0t} \\
\beta_{1t} &= \beta_{1t-1} + v_{1t} \\
\beta_{2t} &= \beta_{2t-1} + v_{2t} \\
\beta_{3t} &= \beta_{3t-1} + v_{3t}
\end{aligned} \tag{3}$$

which allows for all parameters to vary with time and for each parameter to follow a random walk. The four shocks (v_1 , v_2 , v_3 , and v_4) are assumed to independent of each other as well as being independent of ε_t . This model is estimated via maximum likelihood and the Kalman filter using data from 1955Q1 to 2011Q1.

The estimates for the coefficients in (3) on the inflation variable can be found in Figure 3, for the output gap variable in Figure 4, and the unemployment variable in Figure 5. First looking at Figure 2 we see that at the end of the sample the coefficient on the inflation has increased over time and has been very stable since 1985. The coefficient on inflation during the 70's fluctuated a lot with a sharp increase during the first oil shock in 1973. It appears that the coefficient on inflation has slightly increased since the end of the last recession but estimates for this period should be treated carefully given that the policy rate during this period has reached the zero lower bound.

Figure 3 shows the estimated output gap coefficient for the whole period. We see that the value of this coefficient is close to 0 for most of the last part of the sample and is only relatively large for the very first part of the sample in the late 1950's. The output gap

does show some significance as well during the oil crises of the 70's but after 1985 the coefficient declines to almost 0.

Figure 4 shows the estimated coefficient for unemployment. First note that this coefficient is negative so large negative values reflect periods where the Fed is reacting strongly to unemployment. We see the coefficient on unemployment fluctuating during the sample with unemployment having the largest (most negative) coefficient during the recession of 1981-82. After that the impact of unemployment weakened somewhat with an increase in importance during the jobless recovery after the recession of 2001. Like the output gap coefficient the unemployment coefficient heads to 0 after 2007 but this is most likely due to the fact that the Fed Funds Rate has remained unchanged for a large part of 2008, 2009, and 2010.

As a test of whether this reaction function does a good job of predicting turning points in the policy rate we use the estimated coefficient immediately preceding the recession to make a prediction for the policy rate during the recovery. We do this for each recession since 1955. These pictures are shown in Figures 5 through 12. The blue line in each figure is the actual path of the policy rate and the green line is the predicted path using the value of the coefficients at the start of each recovery and the actual values of the inflation rate, output gap and unemployment rate for each period. It is clear that the predictions are not perfect but it is also clear that the simple reaction function does predict the turning points reasonably accurately, the predictions are off by only a quarter in most cases. For the recovery after 1981Q3 the model predicts the first turning point but

subsequently fails to predict the loosening in 1984 and the subsequent tightening in 1987. One implication of this is that the loosening in 1984 was not due to one the three variables but due to some other issue not included in our model. But generally the estimated reaction function does a good job of mimicking the actual shape of the Fed Funds rate.

Given this we turn to the current recovery and see what our model predicts for the near future.

5. Predictions for the Most Recent Recession

Figures 13 through 15 show the values of inflation, the output gap and unemployment for the most recent recovery. Using these values and estimates from our reaction function we predict the value of the Fed Funds rate. We make two predictions; the first using the values of the coefficients as estimated in real time and the second using the estimates in the last quarter of 2007. These predictions are reported in Figure 16.

Our predicted values for the policy rate are negative for most of the period which is consistent with the actual policy rate staying close to 0 for most of the period. The Fed during this time has followed well document non-standard monetary policy involving other instrument than the Fed Funds rate. We can interpret our predicted Fed Funds rate as a shadow policy rate. We see the predicted policy rate decreasing through all of 2008 and through to the third quarter of 2009. It then has started to increase suggesting that if

the Fed followed the reaction function we estimated they would have started to tighten around the end of 2009. However this would not show up in the usual way as the predicted Fed Funds rate is still negative. Our predicted Fed Funds rate is still negative but has been increasing since the end of 2009. The speed in increase appears to have pick up in the last period of our sample but we should not attempt to draw too many conclusions from this as this up-tick may not prove to be permanent. It is hard to draw strong conclusions from this picture but if the rise in the predicted Fed Funds rate continues at the average rate since the turning point in quarter 3 of 2009 then we would expect the predicted Fed Funds rate to return to positive territory in 2012.⁶ Of course this assumes that the inflation rate, output gap, and unemployment rate all improve at the current rate.

6. Conclusion

This paper presents historical narrative, descriptive, and econometric evidence on the timing of monetary policy in the U.S. after recessions end with respect to the turning points of principal macro-aggregates (but especially unemployment and inflation). We covered 14 business cycles from 1920 to 2007.

⁶ In our analysis we do not account for Quantitative easing, the unconventional expansionary monetary policy the Fed followed from December 2009 through June 2011. The decision to end the program at the end of June 2011 and to keep the system open market portfolio constant was intended to keep monetary policy neutral. But the FOMC in the minutes from its June 2011 meeting indicated that when they do decide to end the policy of accommodation that the tightening would begin with a decision to stop reinvesting principal payments on the assets in the open market account. According to Sack (2011) "...this shrinkage of the balance sheet would amount to a tightening of policy... roughly equivalent to raising the federal funds rate by just over 25 basis points per year over the course of several years."

In general we find that monetary policy tightens close to when unemployment peaks and when inflation troughs. But that the timing is usually dominated by unemployment. We also find that on a number of occasions that monetary policy measured by the monetary base (real and nominal) shows a different pattern than the official policy interest rates.

We found that the timing evidence differed between the interwar period (and in some respects the 1950s) and the post World War II period in a number of respects: First, inflation was not persistent in the interwar (or until the 1960s) so the measure of price stability that mattered most was the price level. In the 1920s and in the 1950s policy tightened when the price level began to rise. Second, in the 1920s (and in the 1950s) tightening occurred when prices rose and before unemployment peaked. We found a few episodes where tightening occurred before recessions ended suggesting that the Fed was following countercyclical policy.

An important fact to note is that since the mid 1960s inflation increased and became persistent for close to 20 years. In those cycles the timing of the tightening doesn't show that the pace of tightening was not sufficient to reduce the rising trend in inflation. Since the mid 1980s during the Great Moderation although inflation was reduced significantly the timing of policy tightening still favored unemployment.

There are several possible reasons for these patterns: First, in the interwar the Fed followed gold standard orthodoxy which placed primary importance on price stability. Second, after World War II and the Employment Act of 1945, the Fed followed a dual

mandate for price stability and high employment. Third, beginning in the 1960s the Fed adhered to Keynesian theories and the Phillips Curve which attached primary importance to low unemployment over low inflation. Fourth, the dominance of unemployment in the timing of tightening in the postwar reflects in addition to Keynesian theory, political pressure by the Congress and the Administration on many occasions to not tighten while unemployment was unacceptably high. Fifth, even in the Great Moderation era since the mid 1980s, after inflation had been significantly reduced and considerable emphasis has been placed on the importance of a credible nominal anchor, the timing of exits favors unemployment. This was evident in the last two cycles. In both cases of jobless recoveries political pressure may have been important.

How will the exit strategy play out for the current cycle? We have taken three different approaches to predicting when the Fed will begin to tighten. First we used data on all the post-WWII recessions to estimate a simple reaction function to infer the relationships between the turning points for inflation and unemployment and the date of the tightening. Second we looked at the two previous recessions which were regarded as jobless recovery recessions and tried to infer what the Fed might do based on their actions during the two most recent recessions. Thirdly, given that the unemployment rate is high in the current recession we also looked at the most recent recession where unemployment was also at a high level – the 1981 recession.

Our analysis points to the Fed beginning to tighten by late 2012 (i.e. raise the Fed Funds rate), although if unemployment continues to decline slowly from its current elevated

level, the Fed's dual mandate, political pressure and or the Fed's experience from the last two recessions may stall the tightening longer.

Table 1a: Descriptive Evidence Policy Variables 1920—1937

Cycle	Narratives	Discount Rate	Real Discount Rate	Base Growth	Real Base Growth	M2 Growth	Real M2 Growth
1. 1920Q1—1923Q1 (1921Q3) ^a	3 ^b	5	--	5	1	2	2
2. 1923Q2—1926Q2 (1924Q3)	3	1	2	0	2	-1	2
3. 1926Q3—1929Q2 (1927Q4)	1	0	0	1	0	0	0
4. 1929Q3—1937Q1 (1933Q1)	14	--	--	3	3	-2	4

^a Numbers in parentheses are the NBER trough dates for each cycle.

^b Numbers in cells represent number of quarters post official NBER trough date the series was determined to have turned. In the case of the policy variables this date was the date of initial tightening. Missing value represent a cycle in which no definitive turning point was identified.

Table 1b: Descriptive Evidence Macro Aggregates 1920—1937

Cycle	Price Level (GNP defl.)	Price Level (CPI)	Real GNP	Industrial Production	Output Gap	Unemployment
1. 1920Q1—1923Q1 (1921Q3) ^a	3 ^b	2	-2	-2	-2	-2
2. 1923Q2—1926Q2 (1924Q3)	0	-2	0	-1	0	-2
3. 1926Q3—1929Q2 (1927Q4)	-2	1	0	0	0	1
4. 1929Q3—1937Q1 (1933Q1)	0	0	0	0	0	-4

^a Numbers in parentheses are the NBER trough dates for each cycle.

^b Numbers in cells represent number of quarters post official NBER trough date the series was determined to have turned. In the case of the policy variables this date was the date of initial tightening. Missing value represent a cycle in which no definitive turning point was identified.

Table 2a: Descriptive Evidence Policy Variables 1948—2007

Cycle	Narratives	Fed. Funds Rate (Discount Rate)	Real Fed Funds Rate (Real Discount Rate)	Base Growth	Real Base Growth	M2 Growth	Real M2 Growth
1. 1948Q4—1953Q1 (1949Q4) ^a	-2 ^b	(2)	(6)	-2	-2	1	0
2. 1953Q2—1957Q2 (1954Q2)	3	2	1	1	1	0	0
3. 1957Q3—1960Q1 (1958Q2)	1	0	0	-1	-1	-1	-1
4. 1960Q2—1969Q3 (1961Q1)	1	1	2	2	2	0	-1
5. 1969Q4—1973Q3 (1970Q4)	1	1	1	0	-2	1	1
6. 1973Q4—1979Q4 (1975Q1)	0	1	0	0	0	0	0
7. 1980Q1—1981Q2 (1980Q3)	3	0	0	-1	-1	-1	-1
8. 1981Q3—1990Q2 (1982Q4)	3	1	-1	0	1	0	0
9. 1990Q3—2000Q4 (1991Q1)	12	9	9	5	5	-1	0
10. 2001Q1—2007Q3 (2001Q4)	10	10	5	0	0	3	-1

^a Numbers in parentheses are the NBER trough dates for each cycle.

^b Numbers in cells represent number of quarters post official NBER trough date the series was determined to have turned. In the case of the policy variables this date was the date of initial tightening. Missing value represent a cycle in which no definitive turning point was identified.

Table 2b: Descriptive Evidence Macro Aggregates 1948—2007

Cycle	Inflation(GNP) (Price Level)	Inflation(CPI) (Price Level)	Real GNP	Industrial Production	Output Gap	Unemployment
1. 1948Q4—1953Q1 (1949Q4) ^a	0(1) ^b	-2(1)	0	-2	0	0
2. 1953Q2—1957Q2 (1954Q2)	0(-2)	1(2)	-1	-1	0	1
3. 1957Q3—1960Q1 (1958Q2)	-1	0	-1	-1	0	0
4. 1960Q2—1969Q3 (1961Q1)	-1	0	-1	-1	0	1
5. 1969Q4—1973Q3 (1970Q4)	-2	0	0	0	0	3
6. 1973Q4—1979Q4 (1975Q1)	0	0	0	0	0	1
7. 1980Q1—1981Q2 (1980Q3)	-1	-1	0	-1	0	0
8. 1981Q3—1990Q2 (1982Q4)	1	0	-1	0	0	0
9. 1990Q3—2000Q4 (1991Q1)	5	0	0	0	2	6
10. 2001Q1—2007Q3 (2001Q4)	-1	-1	-1	0	5	7

^a Numbers in parentheses are the NBER trough dates for each cycle.

^b Numbers in cells represent number of quarters post official NBER trough date the series was determined to have turned. In the case of the policy variables this date was the date of initial tightening.

Figure 1: Comparison of Turning Points for Unemployment and Inflation with Tightening Dates

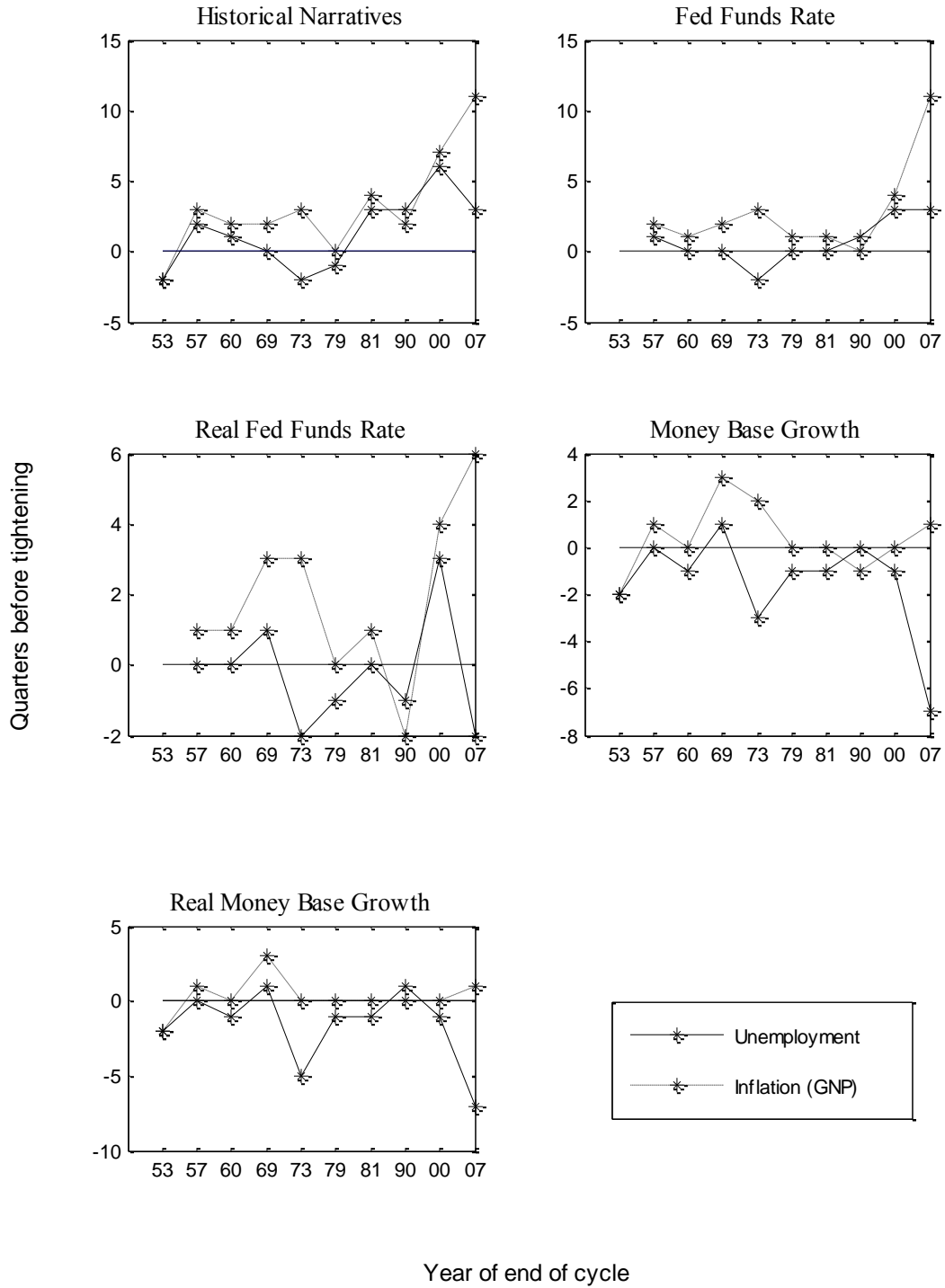


Figure 2: Time-varying Estimates for Inflation Coefficient in (3)

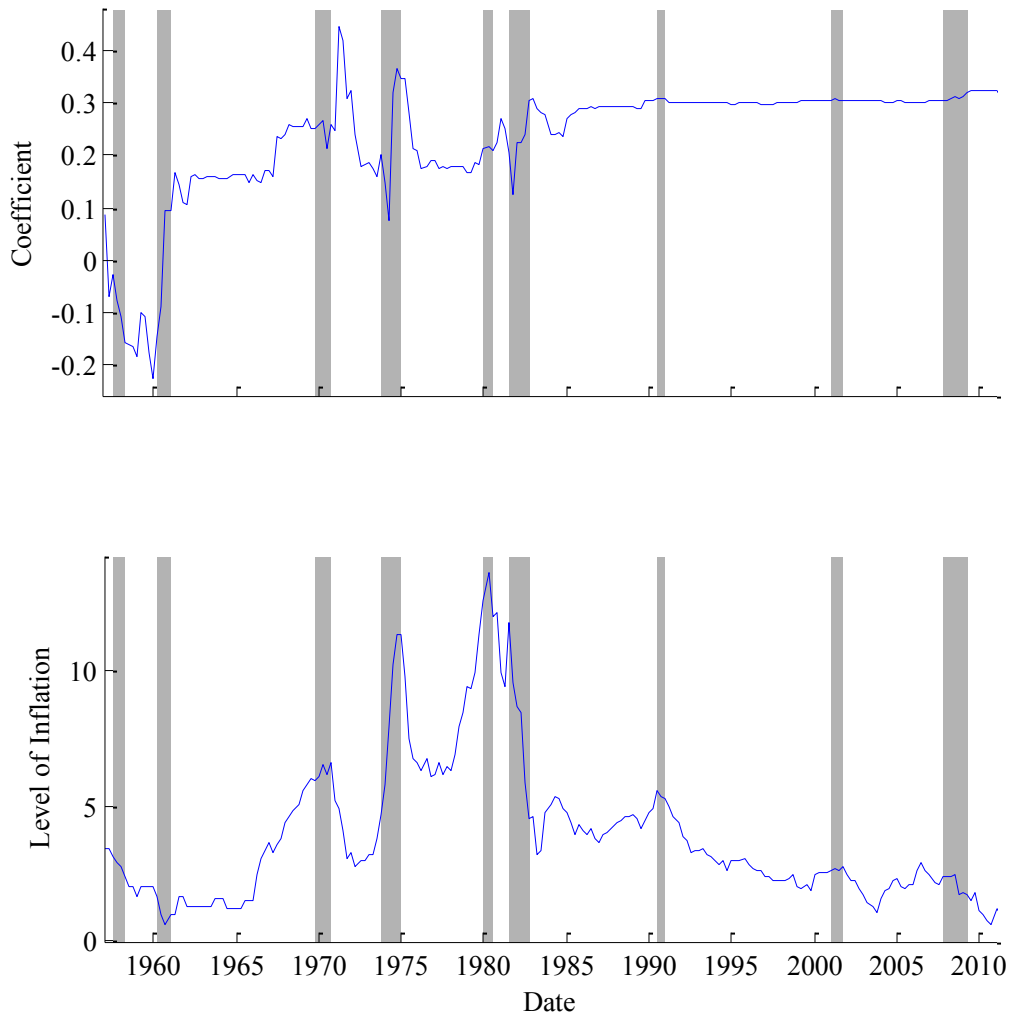


Figure 3: Time-varying estimates for Output-Gap coefficient in (3)

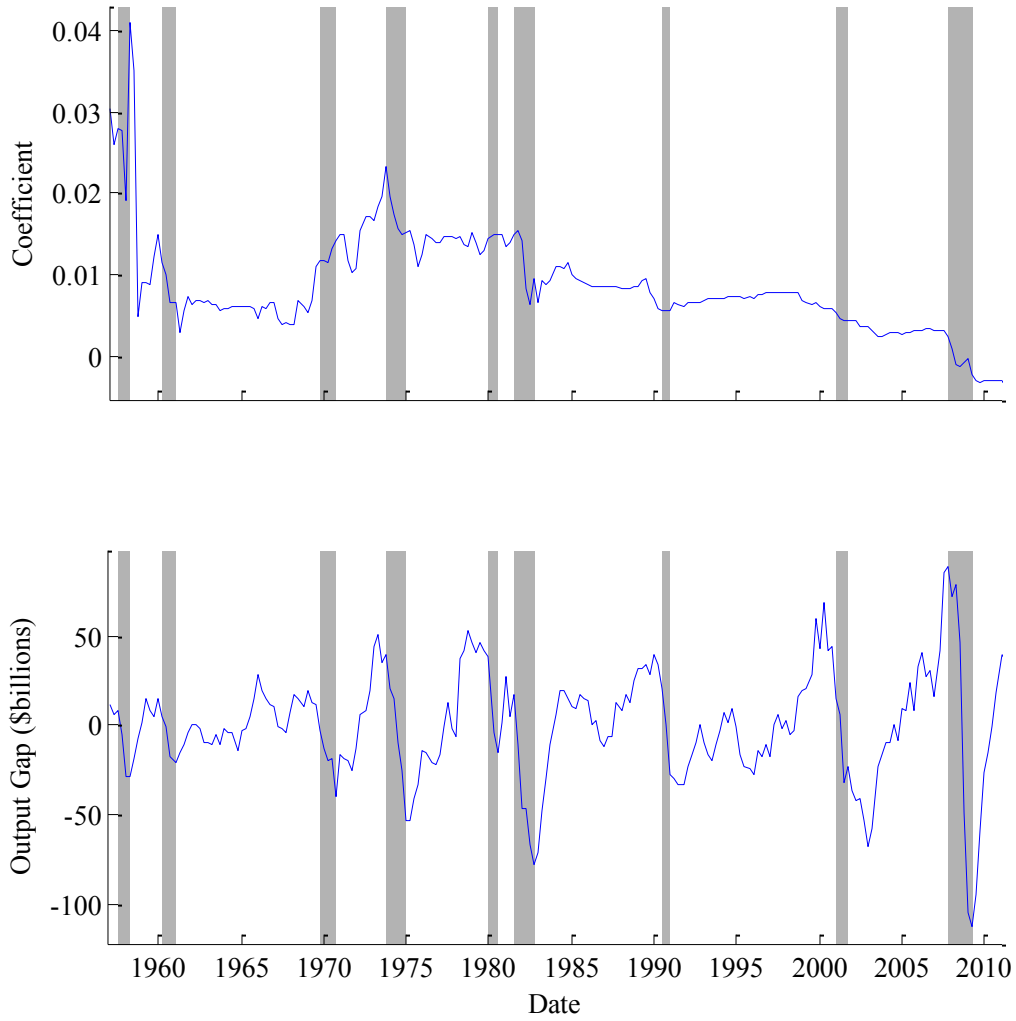


Figure 4: Time-varying estimates for Unemployment coefficient in (3)

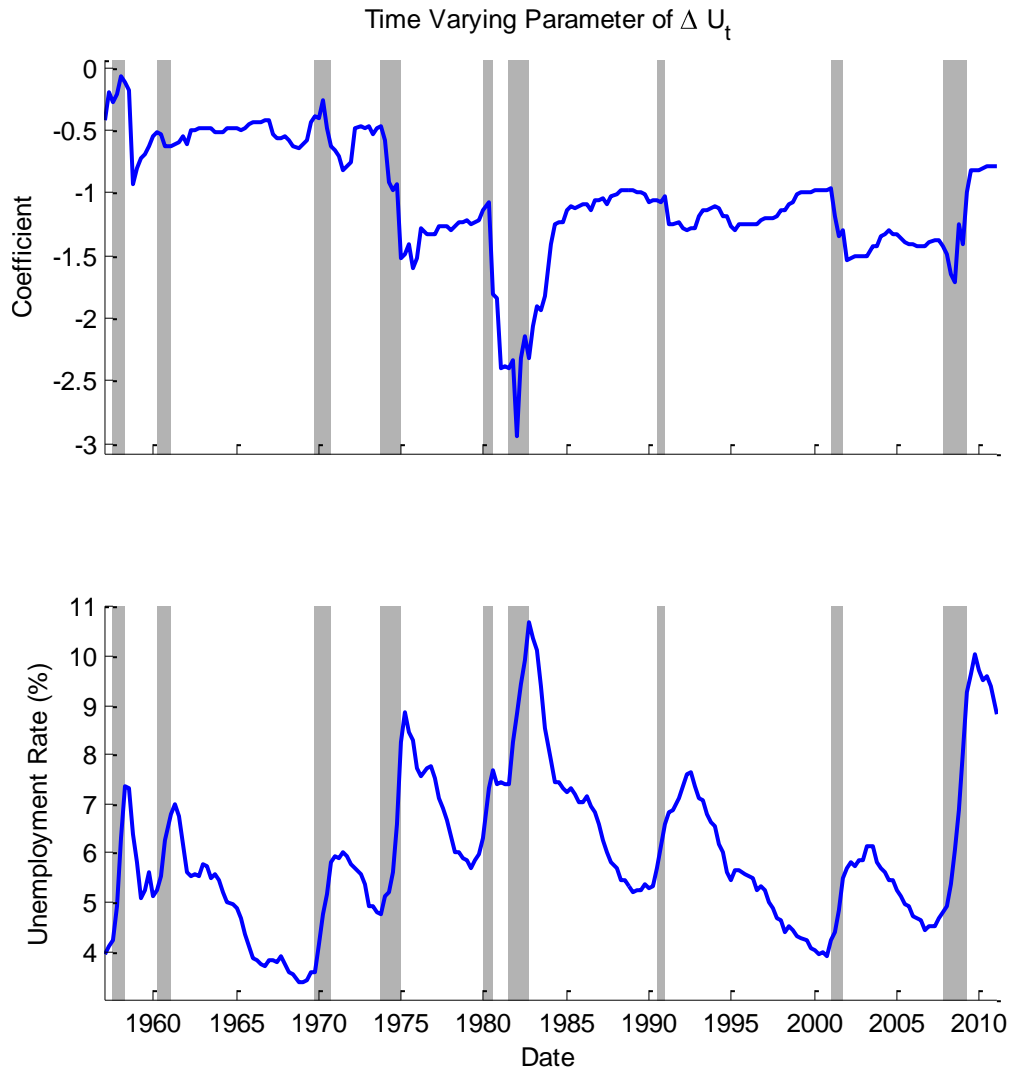


Figure 5: Prediction for 1957Q3 to 1960Q1

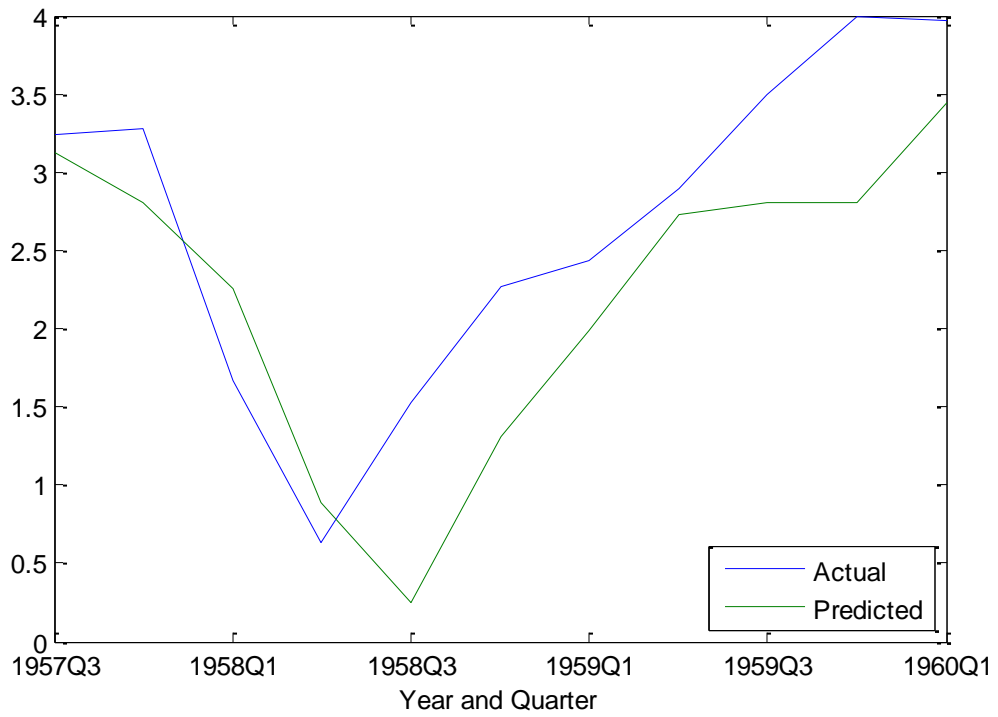


Figure 6: Prediction for 1960Q2 to 1969Q3

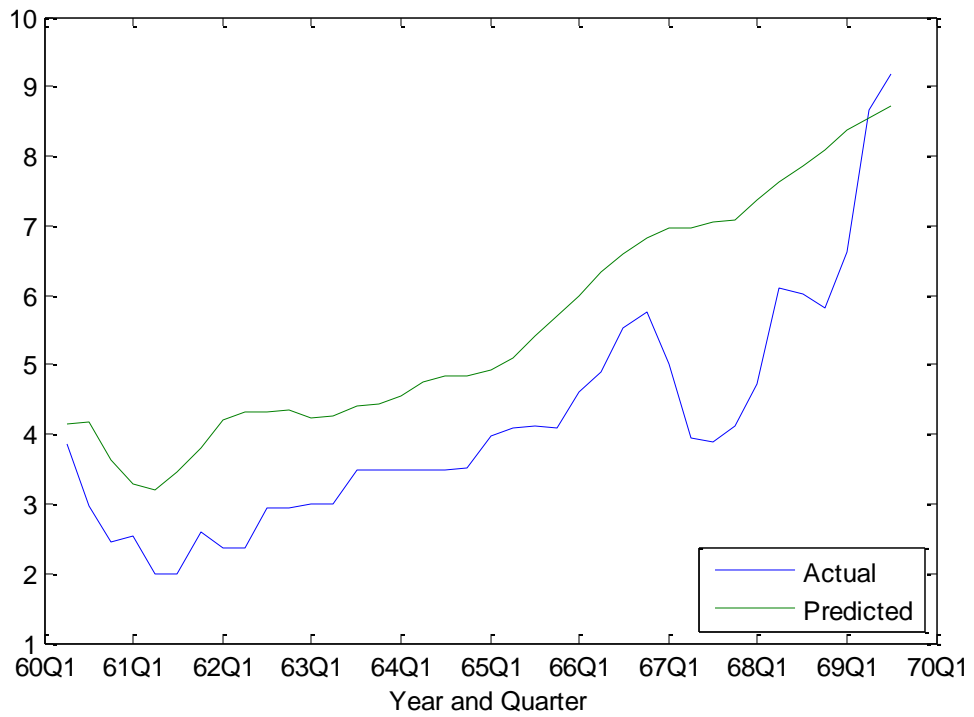


Figure 7: Prediction for 1969Q4 to 1973Q3

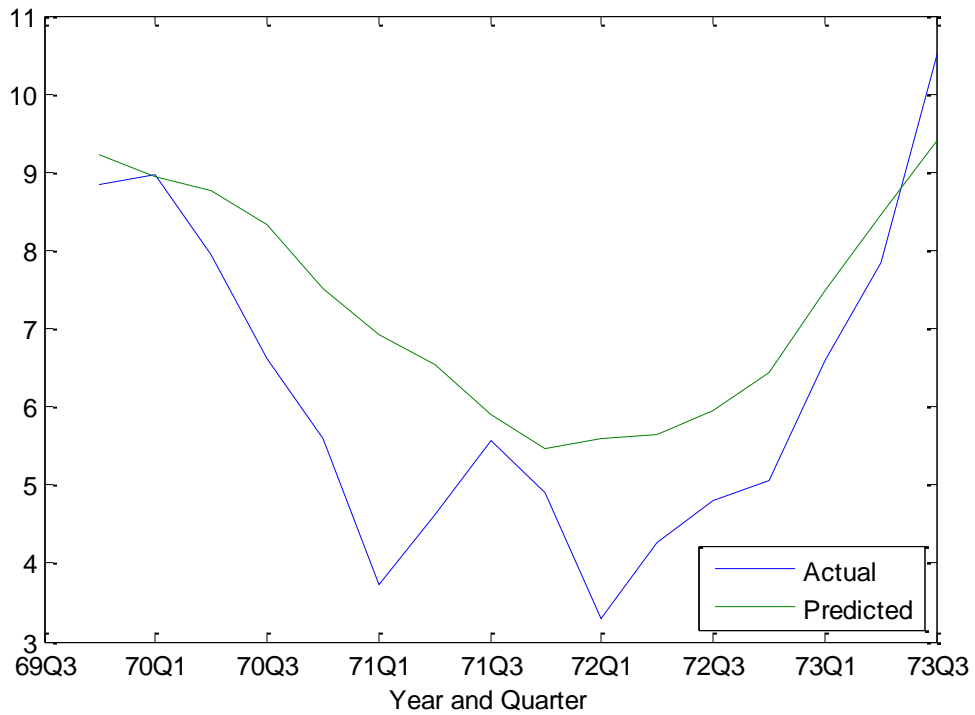


Figure 8: Prediction for 1973Q4 to 1979Q4

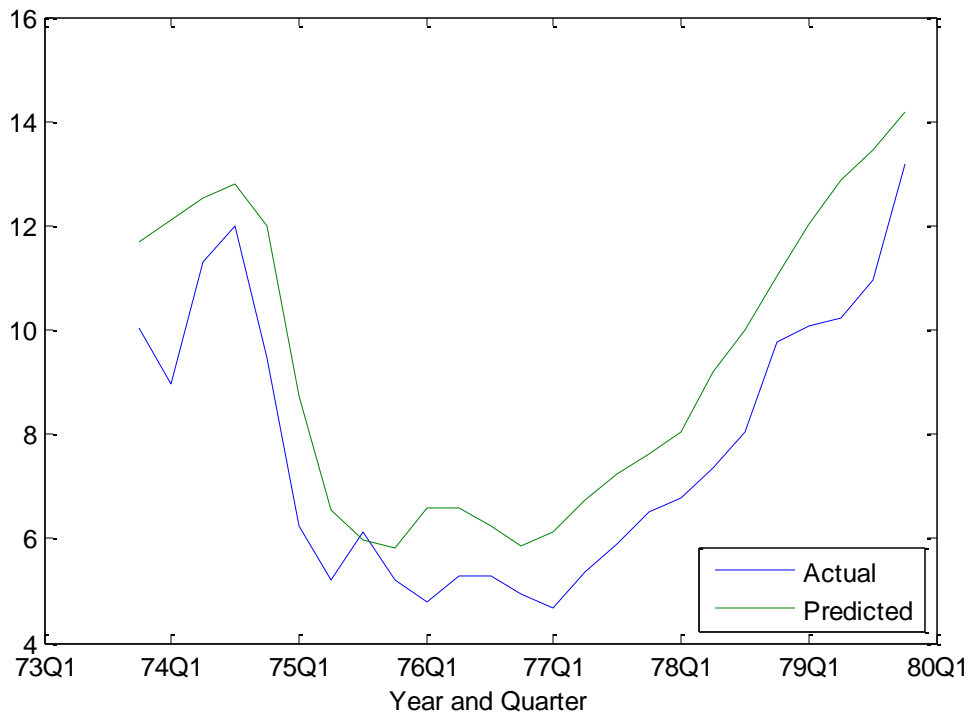


Figure 9: Prediction for 1980Q1 to 1981Q2

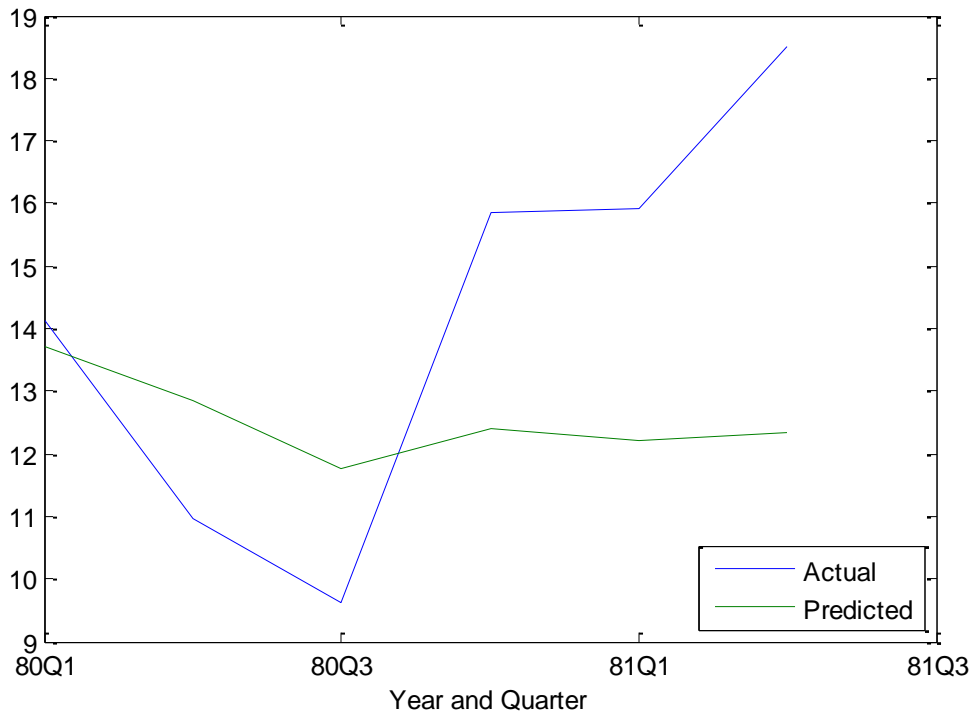


Figure 10: Prediction for 1981Q3 to 1990Q2

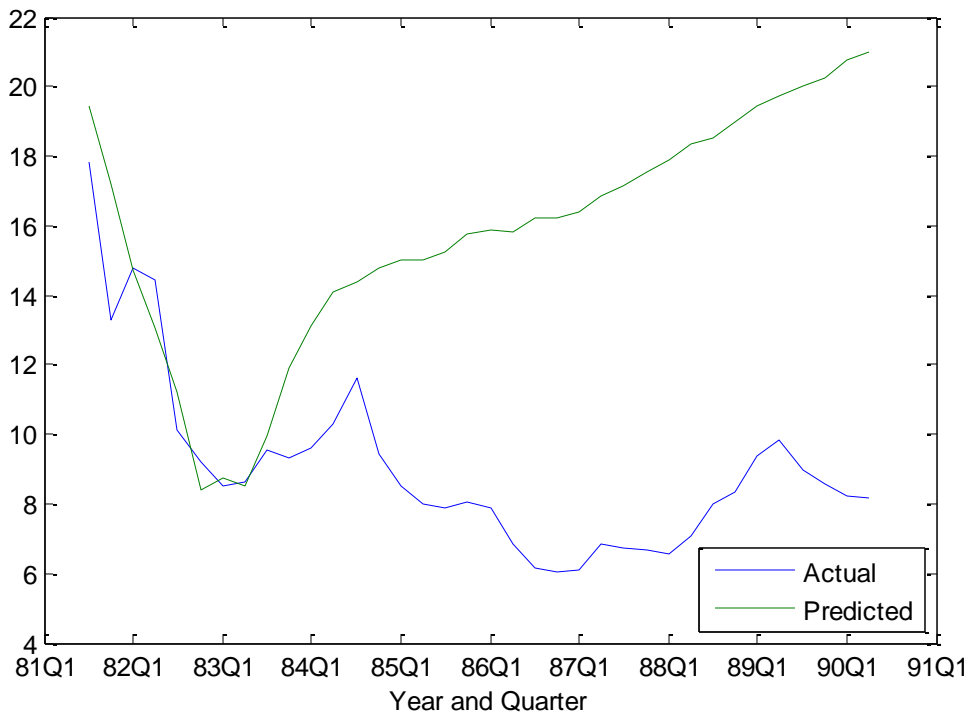


Figure 11: Prediction for 1990Q3 to 2000Q4

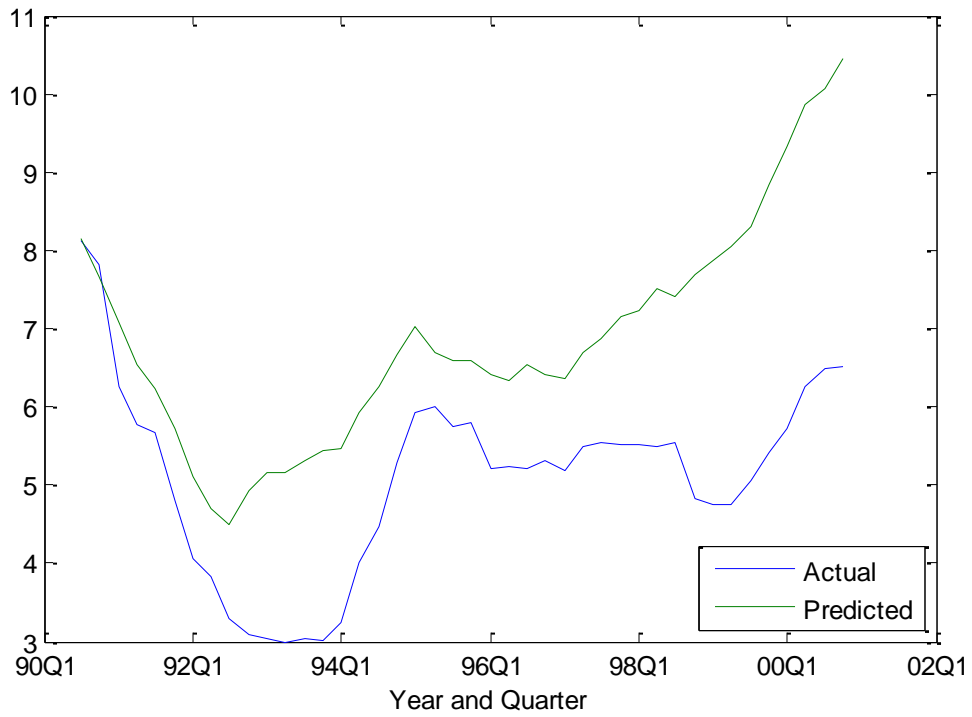


Figure 12: Prediction for 2001Q1 to 2007Q4

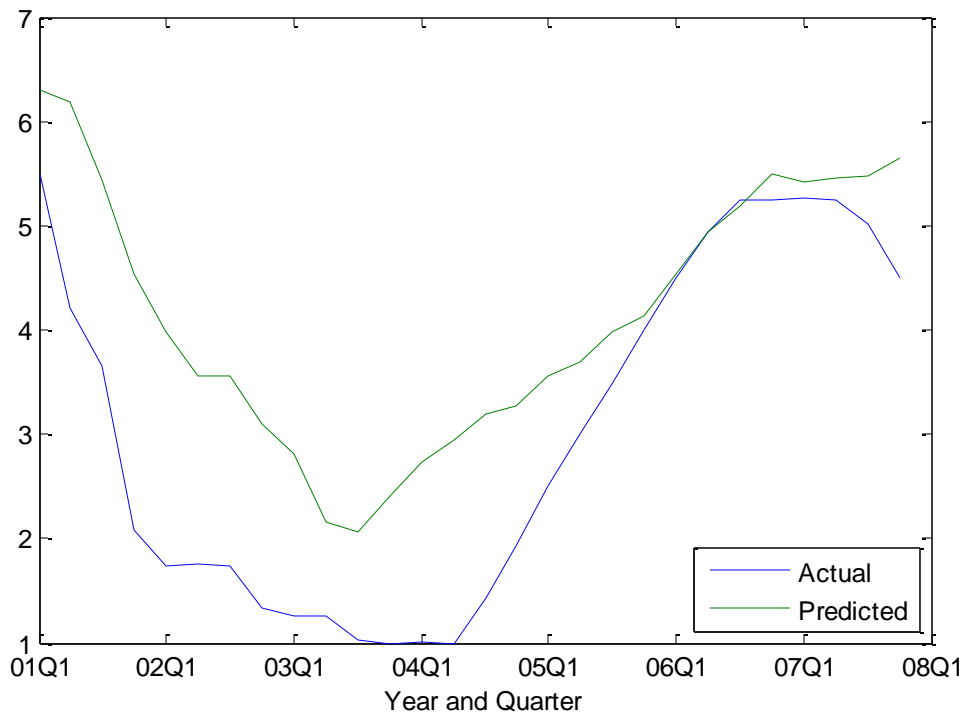


Figure 13: Inflation Rate for most recent Cycle

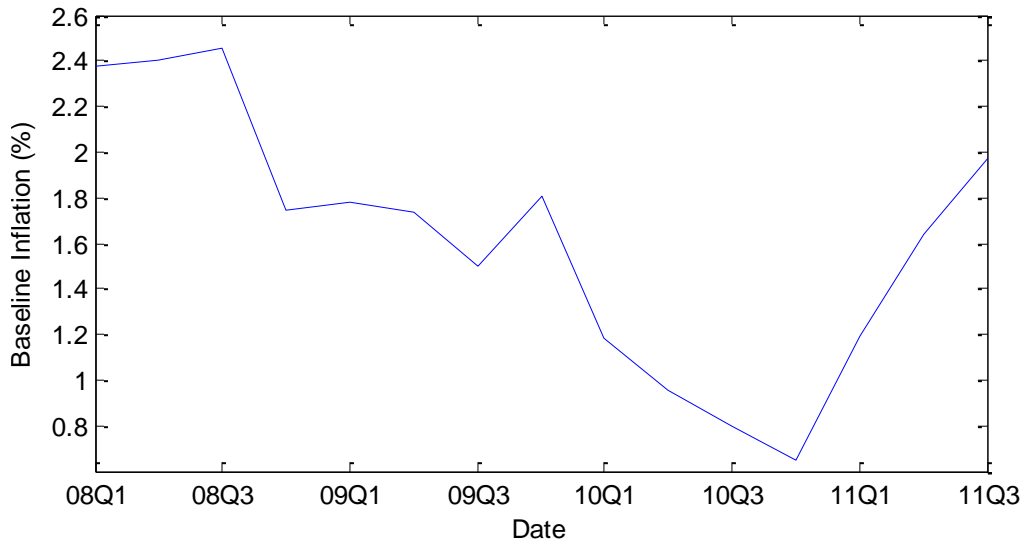


Figure 14: Output Gap for most recent Cycle

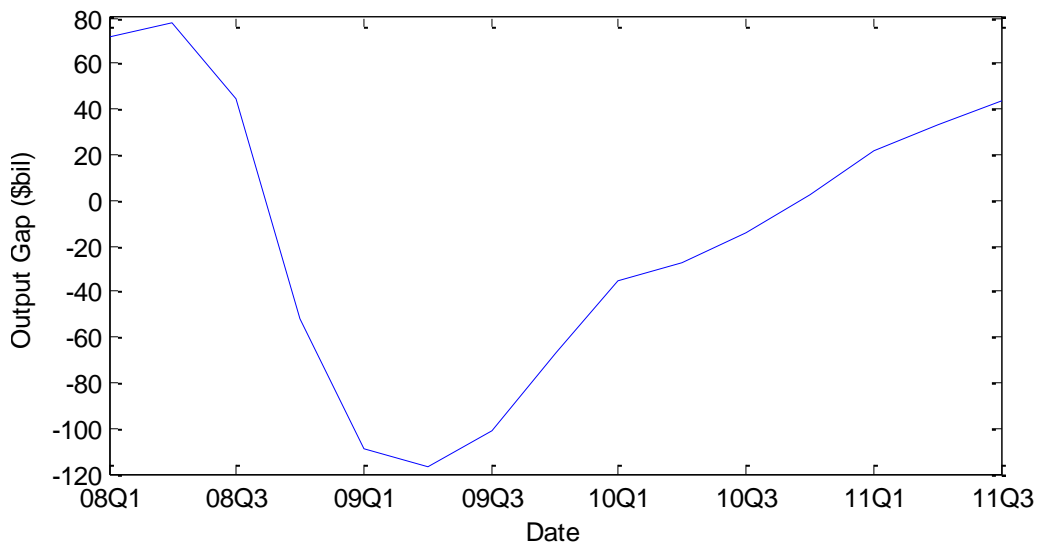


Figure 15: Unemployment Rate for most recent Cycle

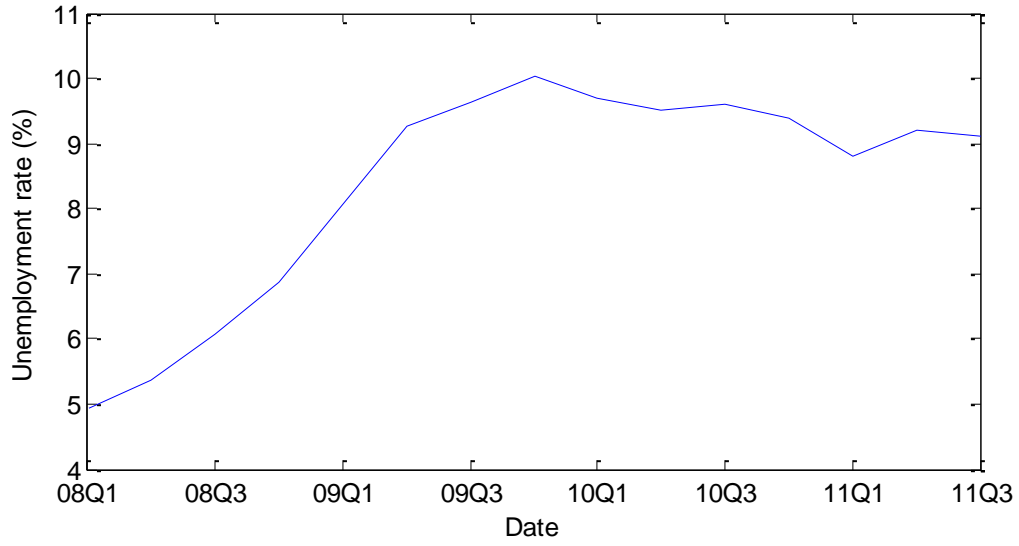
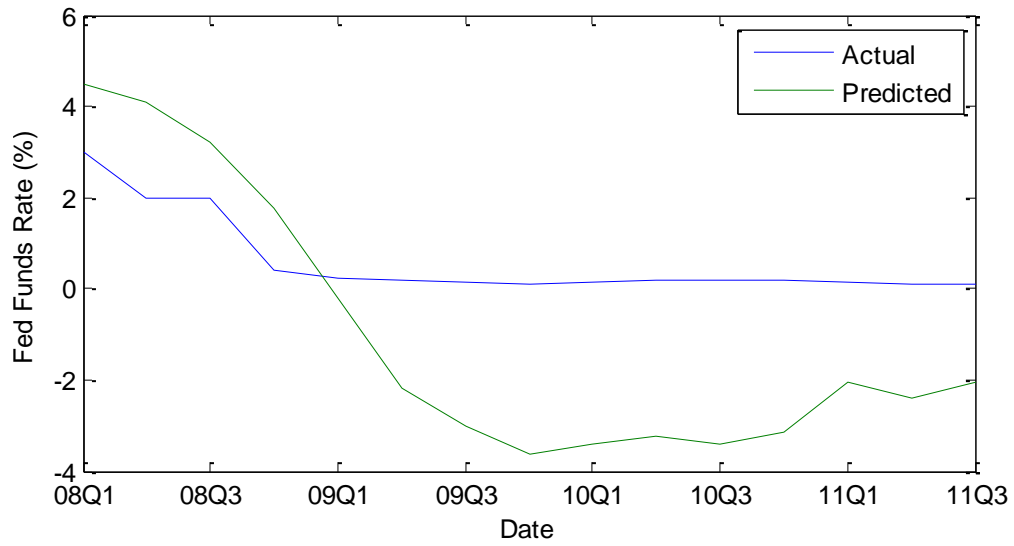


Figure 16: Predicted Fed Funds Rate for the most recent Recovery



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Appendix

A1. Data appendix

Table A1: Data Definitions

Variable	Source
Discount rate	Obtained from the Board of Governors database (H.15). Before 1954 the discount rate is the New York Fed discount rate. The discount rate series is discontinued after 2002 and the Discount Window Primary Credit rate is used after 2002. Monthly data converted to quarterly data using quarterly averages.
Federal Funds Rate	Effective Federal Funds rate (FEDFUNDS): Obtained from St Louis Fed data base (FRED) ^a . Monthly data converted to Quarterly data using quarterly averages. Real rate obtained by subtracting inflation rate (computed using GNP deflator).
Money Base	St Louis adjusted monetary base (seasonally adjusted, AMBSL): Obtained from FRED. Monthly data converted to quarterly data using quarterly averages. Real rate obtained by dividing by GNP deflator. Growth rates are one quarter growth rates expressed as an annualized rate.
M2	M2 from Balke and Gordon (1986) until 1983. After 1983 used M2 series from FRED database (seasonally adjusted, M2SL). Monthly data converted to quarterly data using quarterly averages. The two series were spliced at join. Real data obtained by dividing by GNP deflator. Growth rates are one quarter growth rates expressed as an annualized rate.
Price Level (GNP)	GNP deflator obtained from Balke and Gordon (1986) until 1983. After that used GNP deflator from FRED database (seasonally adjusted, GNPDEF). The two series were spliced at join.
Price Level (CPI)	Consumer price index for all urban consumers: All items. Obtained from FRED database (CPIAUCNS). Monthly data converted to quarterly data using quarterly averages.
Inflation (GNP)	Percentage one quarter change in GNP deflator expressed at an annualized rate.
Inflation (CPI)	Percentage one quarter change in CPI expressed at an annualized rate.
Real GNP	Real Gross National Product obtained from Balke and Gordon (1986) for periods up until 1983. Afterwards used quarterly GNP data from FRED database (GNP). GNP price deflator from FRED spliced with Balke and Gordon (1986) price deflator. Real GNP after 1983 is nominal GNP divided by spliced GNP deflator series.
Industrial Production	Obtained from FRED database (INDPRO). Monthly series converted to quarterly series using quarterly averages.
Unemployment	Obtained from Bureau of Labor Statistics. Unemployment rate: Civilian Labor Force (LNS14000000, seasonally adjusted).

Output Gap Monthly data converted to quarterly data using quarterly averages.
Proportional deviation of real GNP from long-run trend. Computed
as the deviations of the logarithm of real GNP from its long-run
trend as computed using Hodrick-Prescott filter with smoothing
parameter $\lambda = 1600$.

^a. <http://research.stlouisfed.org/fred2/>

A2. Dates of Turning points of series

Table A2-a: Turning Dates: Policy Variables 1920—1937

Cycle	Narratives	Discount Rate	Real Discount Rate	Base Growth	Real Base Growth	M2 Growth	Real M2 Growth
1. 20Q1-23Q1 (1921Q3) ^a	1922Q2	1922Q4	--	1922Q4	1921Q4	1922Q1	1922Q1
2. 23Q2-26Q2 (1924Q3)	1925Q2	1924Q4	1925Q1	1924Q3	1925Q1	1924Q2	1925Q1
3. 26Q3-29Q2 (1927Q4)	1928Q1	1927Q4	1927Q4	1928Q1	1927Q4	1927Q4	1927Q4
4. 29Q3-37Q1 (1933Q1)	1936Q3	--	--	1933Q4	1933Q4	1932Q3	1934Q1

^a Dates in parentheses are the NBER trough dates for each cycle. Missing value represent a cycle in which no definitive turning point was identified.

Table A2-b: Turning Dates: Macro Aggregates 1920—1937

Cycle	Price Level (GNP deflator.)	Price Level (CPI)	Real GNP	Industrial Production	Output Gap	Unemployment
1. 20Q1-23Q1 (1921Q3) ^a	1922Q2	1922Q1	1921Q1	1921Q1	1921Q1	1921Q1
2. 23Q2-26Q2 (1924Q3)	1924Q3	1924Q1	1924Q3	1924Q2	1924Q3	1924Q1
3. 26Q3-29Q2 (1927Q4)	1927Q2	1928Q1	1927Q4	1927Q4	1927Q4	1928Q1
4. 29Q3-37Q1 (1933Q1)	1933Q1	1933Q1	1933Q1	1933Q1	1933Q1	1932Q1

^a Dates in parentheses are the NBER trough dates for each cycle.

Table A3-a: Turning Dates: Policy Variables 1948—2007

Cycle	Narratives	Fed. Funds Rate (Discount Rate)	Real Fed Funds Rate (Real Discount Rate)	Base Growth	Real Base Growth	M2 Growth	Real M2 Growth
1. 48Q4-53Q1 (1949Q4) ^a	1949Q2	(1950Q2)	(1951Q1)	1949Q2	1949Q2	1950Q1	1949Q4
2. 53Q2-57Q2 (1954Q2)	1955Q1	1954Q4	1954Q3	1954Q3	1954Q3	1954Q2	1954Q2
3. 57Q3-60Q1 (1958Q2)	1958Q3	1958Q2	1958Q2	1958Q1	1958Q1	1958Q1	1958Q1
4. 60Q2-69Q3 (1961Q1)	1961Q2	1961Q2	1961Q3	1961Q3	1961Q3	1961Q1	1960Q4
5. 69Q4-73Q3 (1970Q4)	1971Q1	1971Q1	1971Q1	1970Q4	1970Q2	1971Q1	1971Q1
6. 73Q4-79Q4 (1975Q1)	1975Q1	1975Q2	1975Q1	1975Q1	1975Q1	1975Q1	1975Q1
7. 80Q1-81Q2 (1980Q3)	1981Q2	1980Q3	1980Q3	1980Q2	1980Q2	1980Q2	1980Q2
8. 81Q3-90Q2 (1982Q4)	1983Q3	1983Q1	1982Q3	1982Q4	1983Q1	1982Q4	1982Q4
9. 90Q3-00Q4 (1991Q1)	1994Q1	1993Q2	1993Q2	1992Q2	1992Q2	1990Q4	1991Q1
10. 01Q1-07Q3 (2001Q4)	2004Q2	2004Q2	2003Q1	2001Q4	2001Q4	2002Q3	2001Q3

^a Dates in parentheses are the NBER trough dates for each cycle.

Table 2b: Turning Dates: Macro Aggregates 1948—2007

Cycle	Inflation(GNP) (Price Level)	Inflation(CPI) (Price Level)	Real GNP	Industrial Production	Output Gap	Unemployment
1. 48Q4-53Q1 (1949Q4) ^a	1949Q4 (1950Q1)	1949Q2 (1950Q1)	1949Q4	1949Q2	1949Q4	1949Q4
2. 53Q2-57Q2 (1954Q2)	1954Q2 (1953Q4)	1954Q3 (1954Q4)	1954Q1	1954Q1	1954Q2	1954Q3
3. 57Q3-60Q1 (1958Q2)	1958Q1	1958Q2	1958Q1	1958Q1	1958Q2	1958Q2
4. 60Q2-69Q3 (1961Q1)	1960Q4	1961Q1	1960Q4	1960Q4	1961Q1	1961Q2
5. 69Q4-73Q3 (1970Q4)	1970Q2	1970Q4	1970Q4	1970Q4	1970Q4	1971Q3
6. 73Q4-79Q4 (1975Q1)	1975Q1	1975Q1	1975Q1	1975Q1	1975Q1	1975Q2
7. 80Q1-81Q2 (1980Q3)	1980Q2	1980Q2	1980Q3	1980Q2	1980Q3	1980Q3
8. 81Q3-90Q2 (1982Q4)	1983Q1	1982Q4	1982Q3	1982Q4	1982Q4	1982Q4
9. 90Q3-00Q4 (1991Q1)	1984Q1	1991Q1	1991Q1	1991Q1	1991Q3	1984Q2
10. 01Q1-07Q3 (2001Q4)	2001Q3	2001Q3	2001Q3	2001Q4	2003Q1	2003Q7

^a Date in parentheses are the NBER trough dates for each cycle.

A3. Figures of Data and Turning Points

Figure A1: Nominal Discount Rate

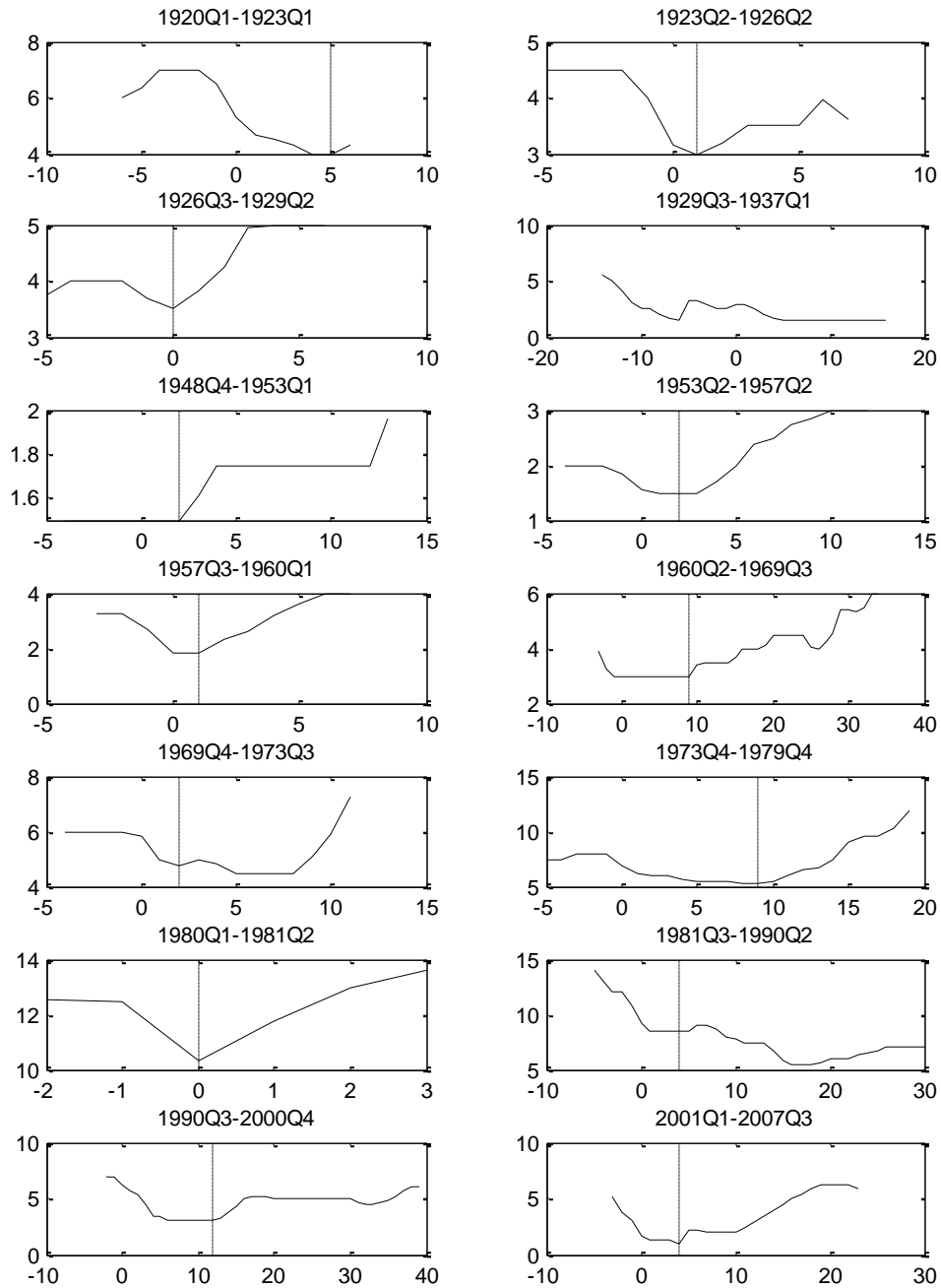


Figure A2: Federal Funds Rate

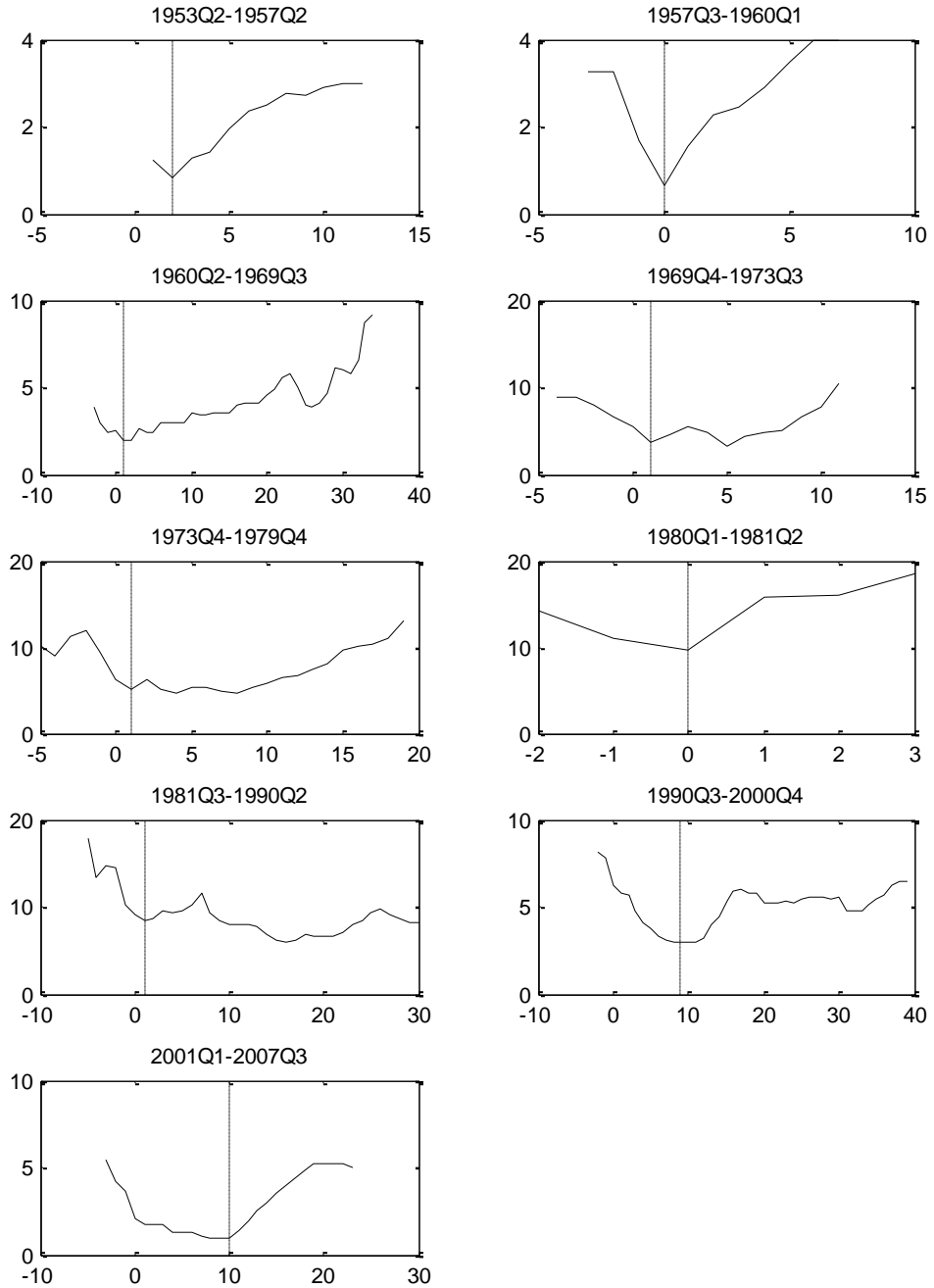


Figure A3: Real Discount Rate

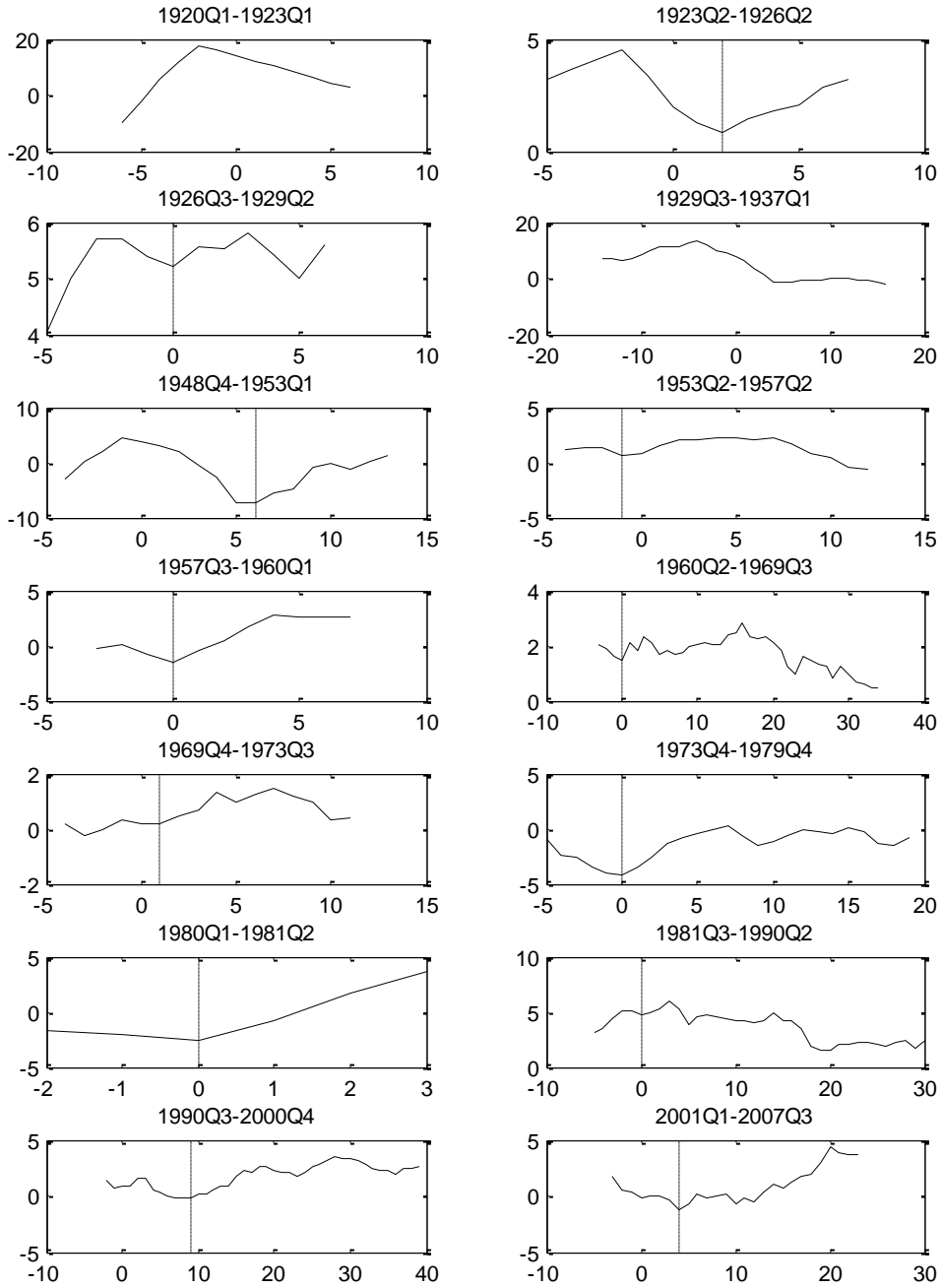


Figure A4: Real Federal Funds Rate

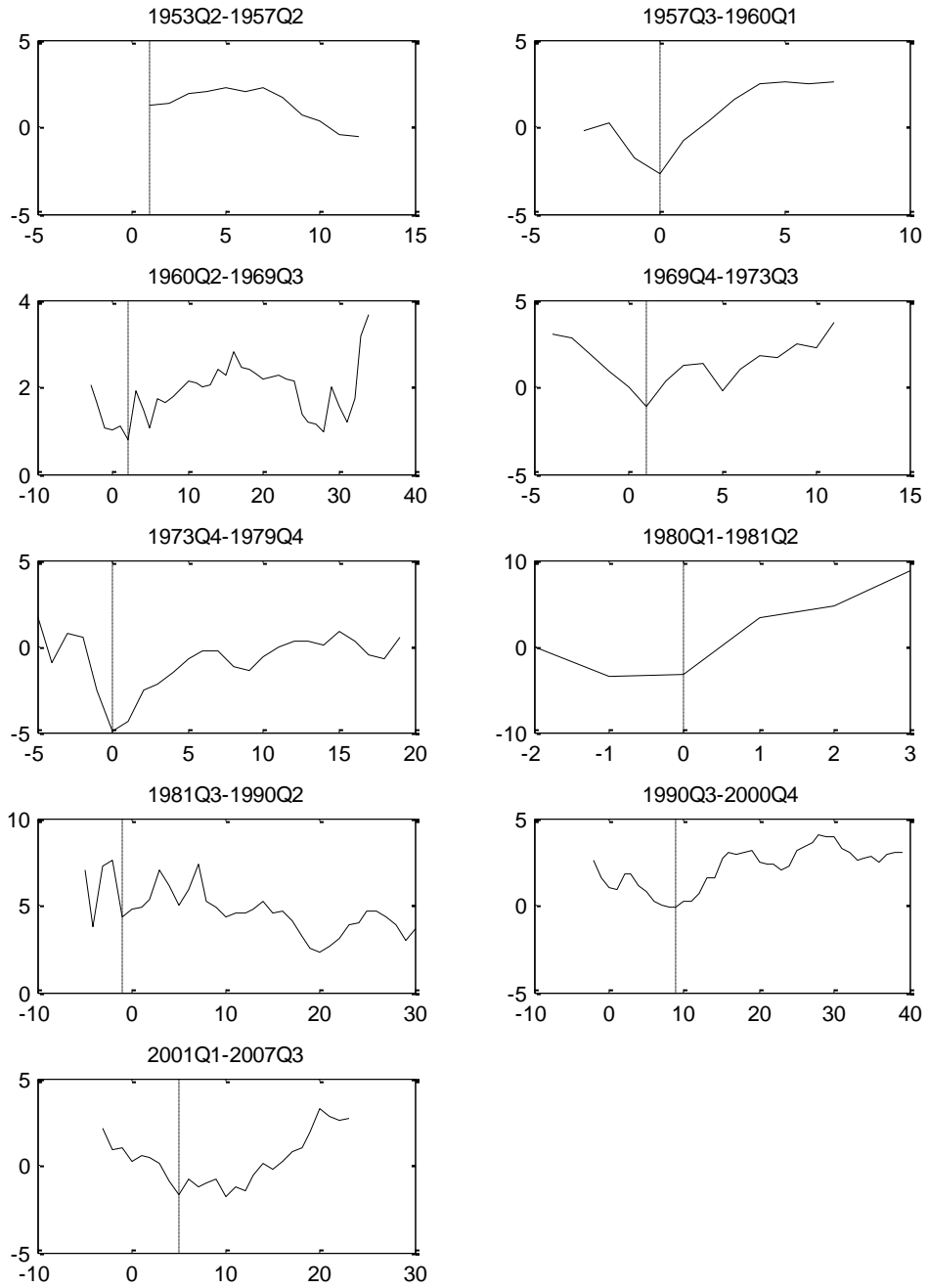


Figure A5: Base Growth

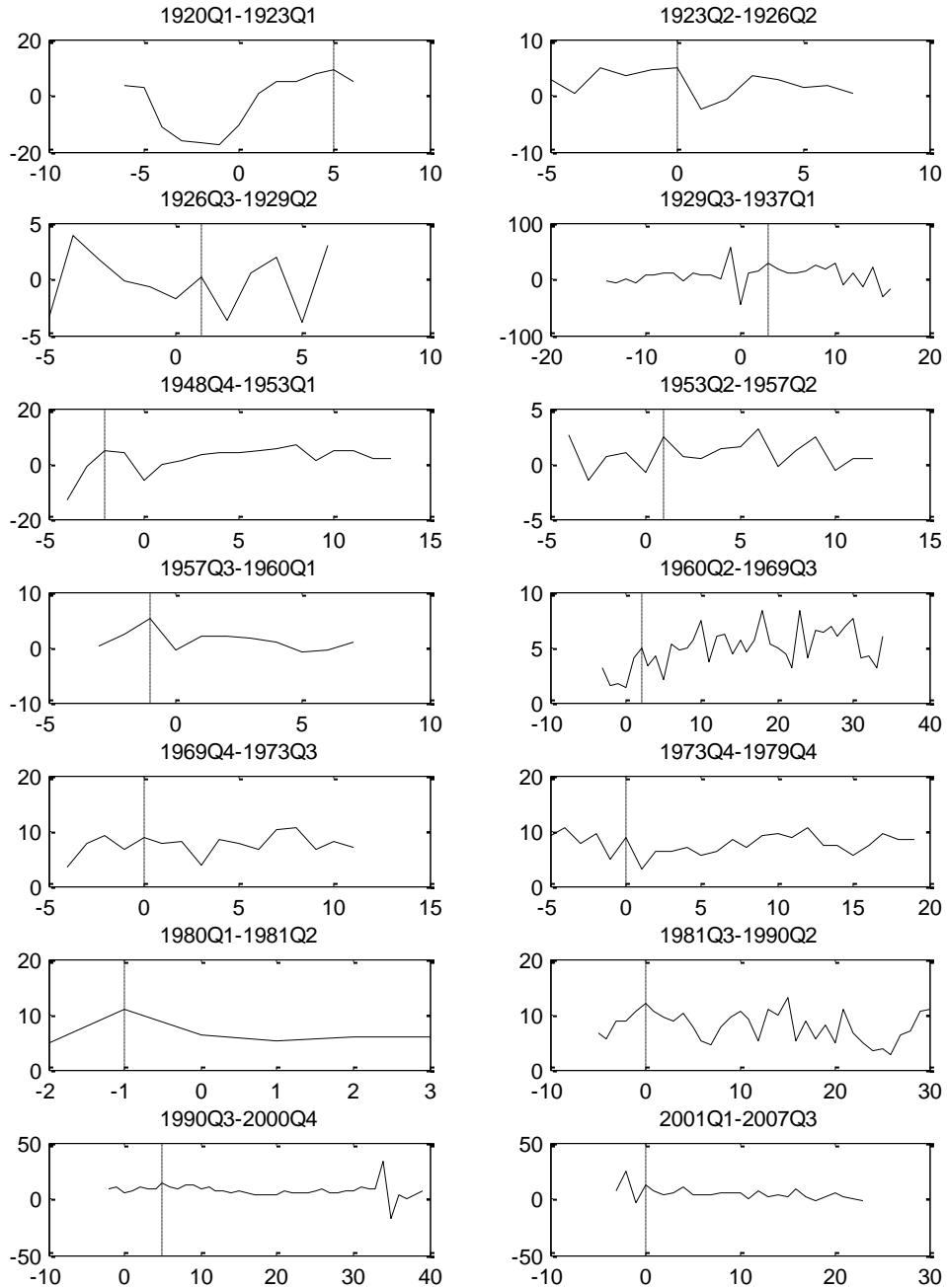


Figure A6: Real Base Growth

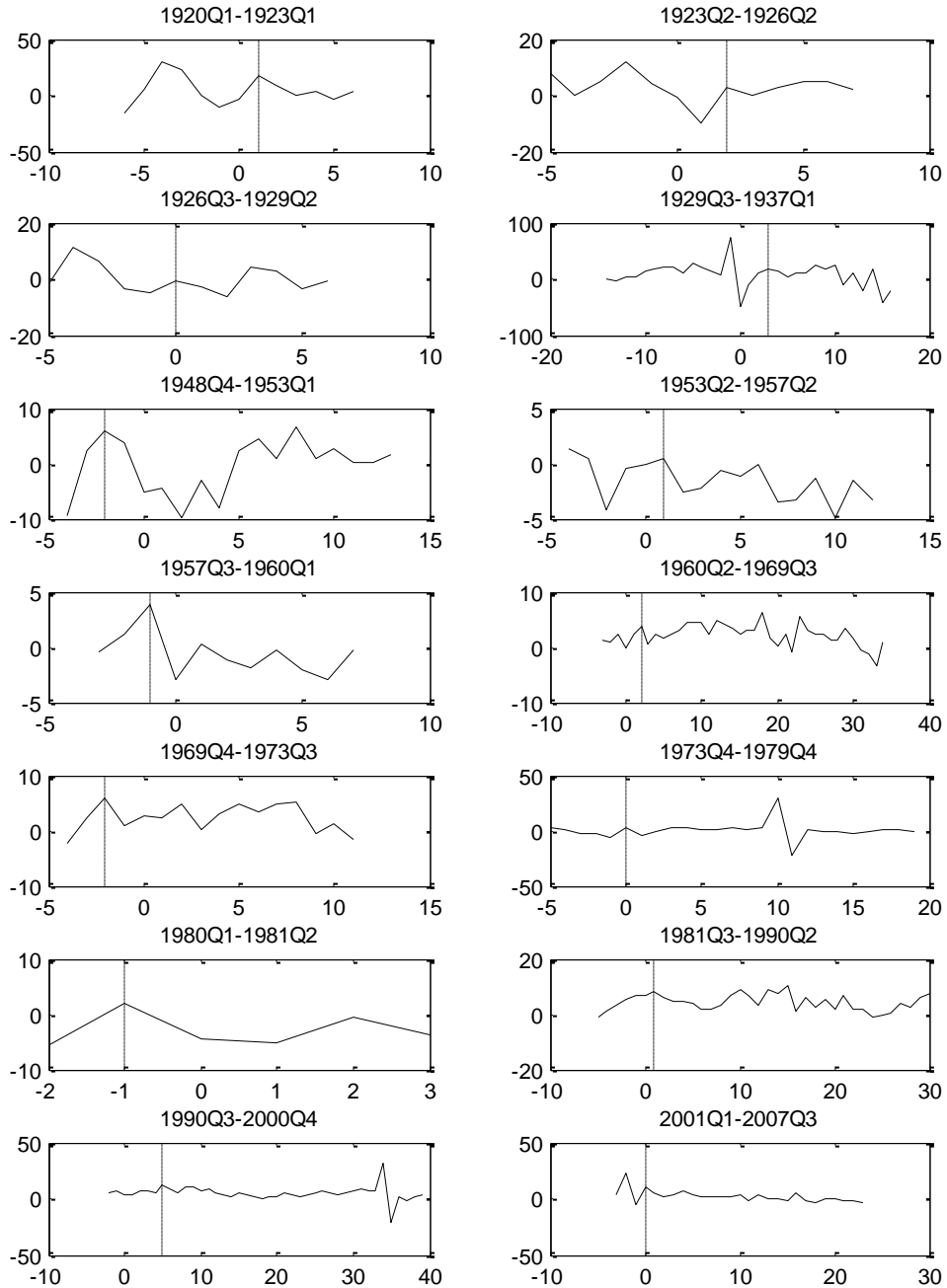


Figure A7: M2 Growth

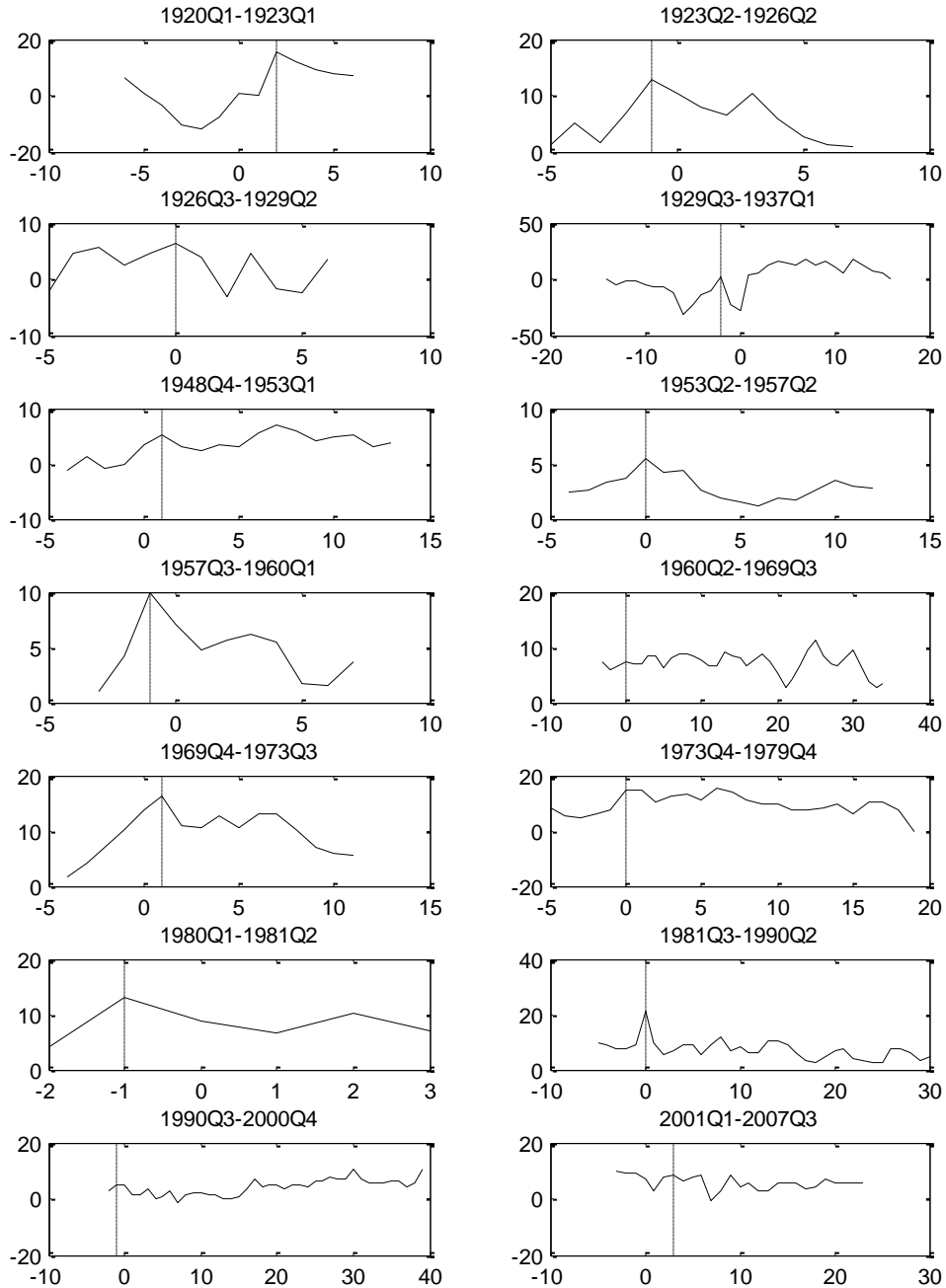


Figure A8: Real M2 Growth

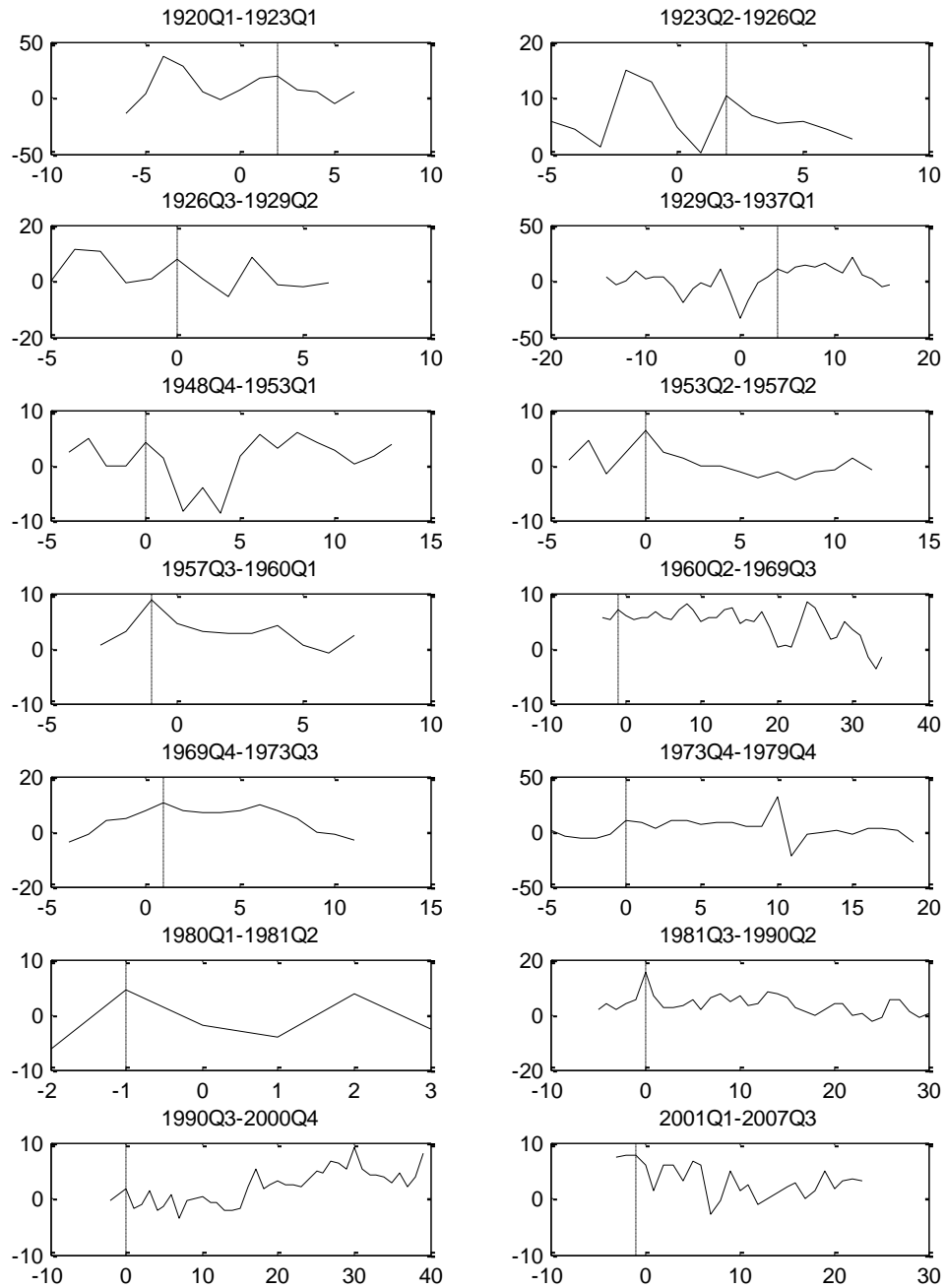


Figure A9: Price Level (GNP deflator)

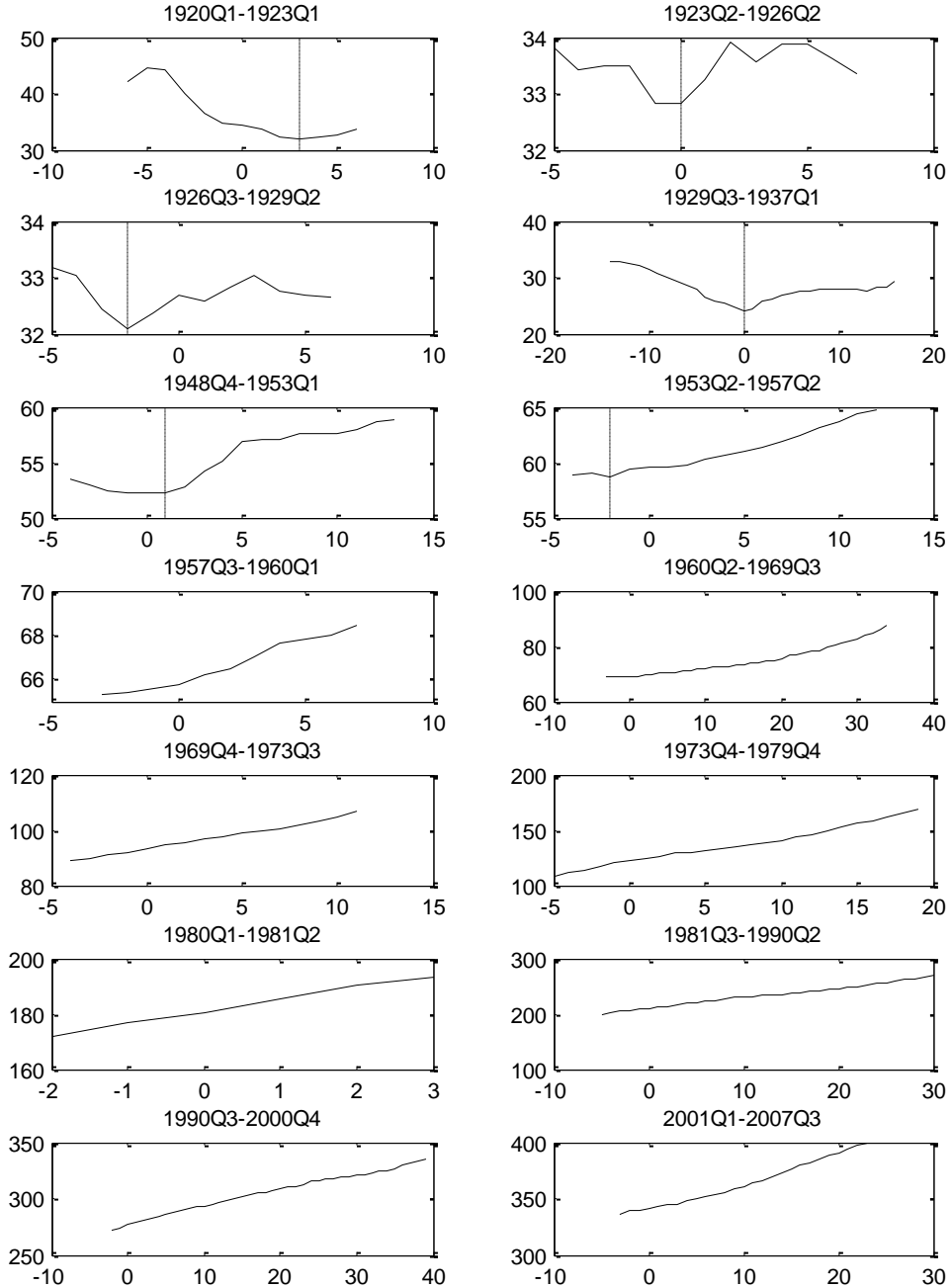


Figure A10: Price Level (CPI)

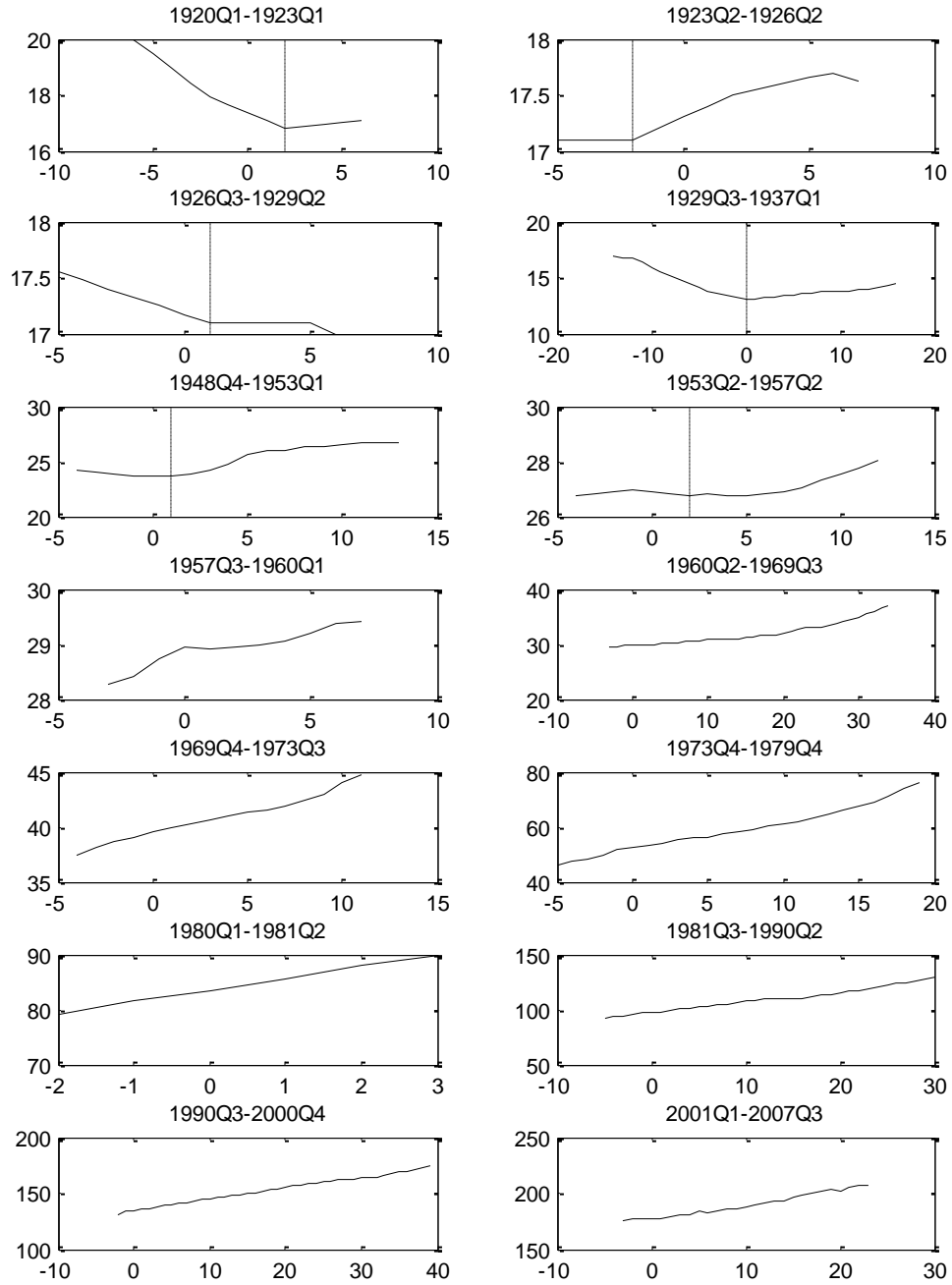


Figure A11: Inflation (GNP deflator)

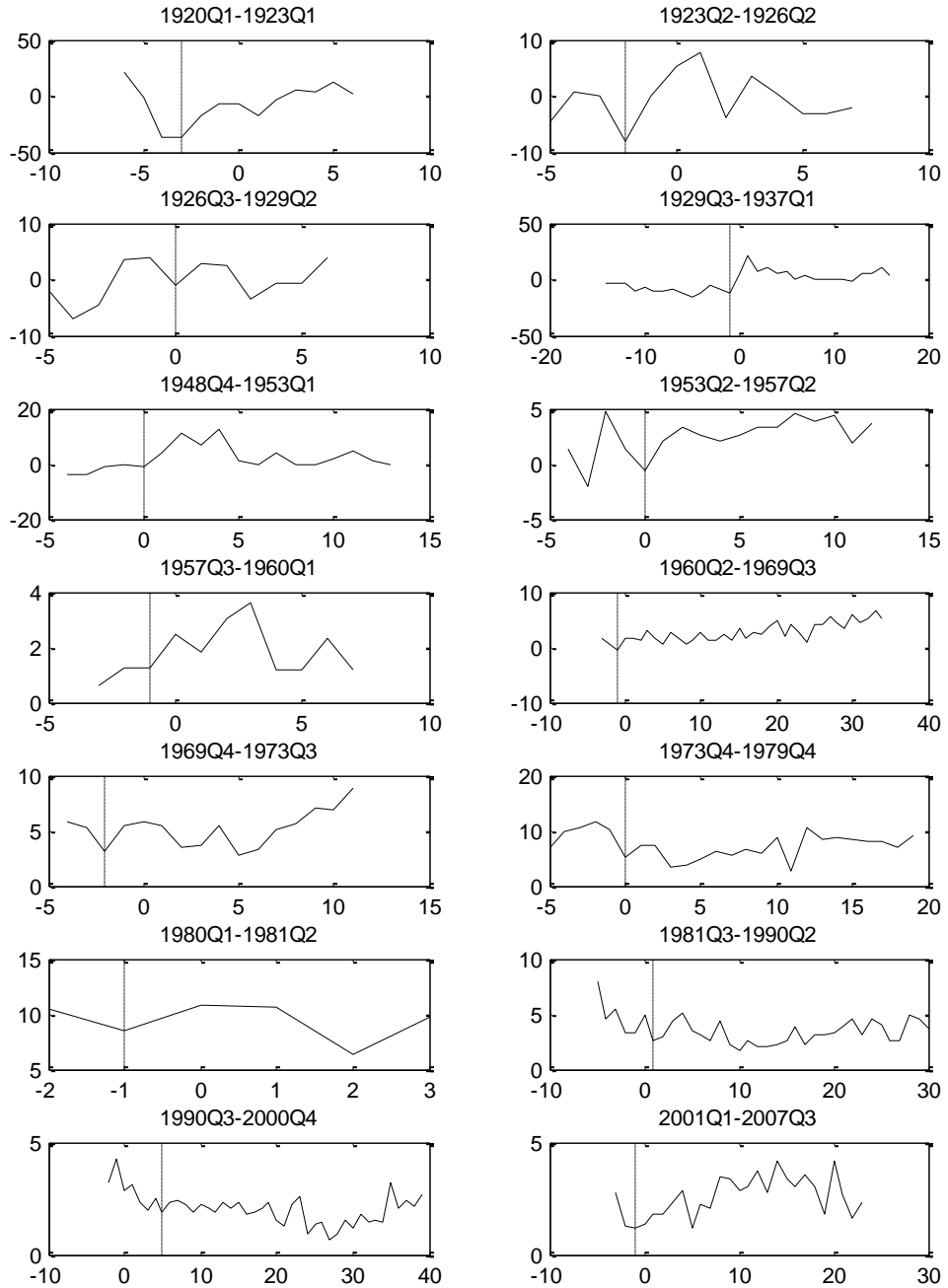


Figure A12: Inflation (CPI)

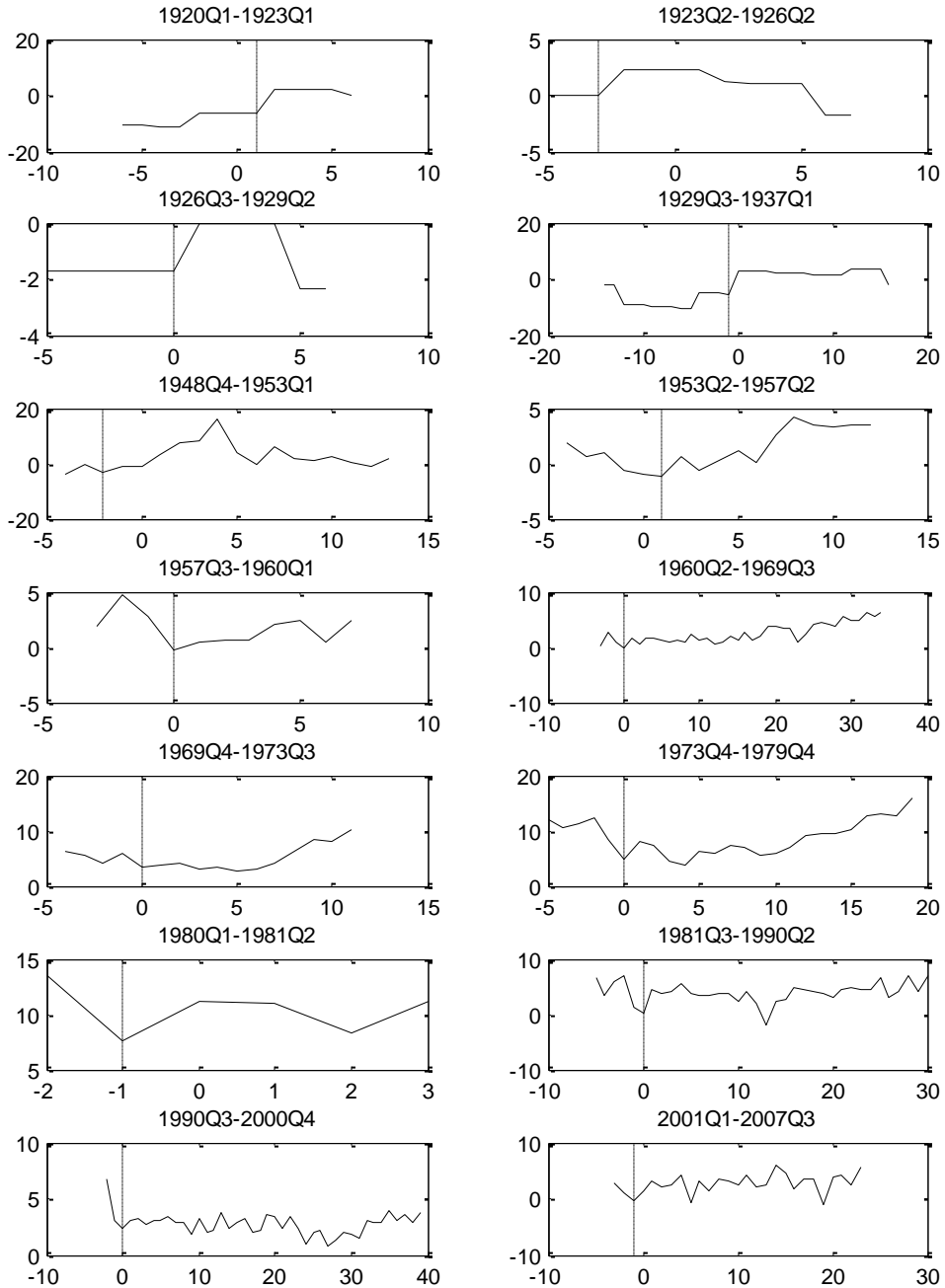


Figure A13: Real GNP

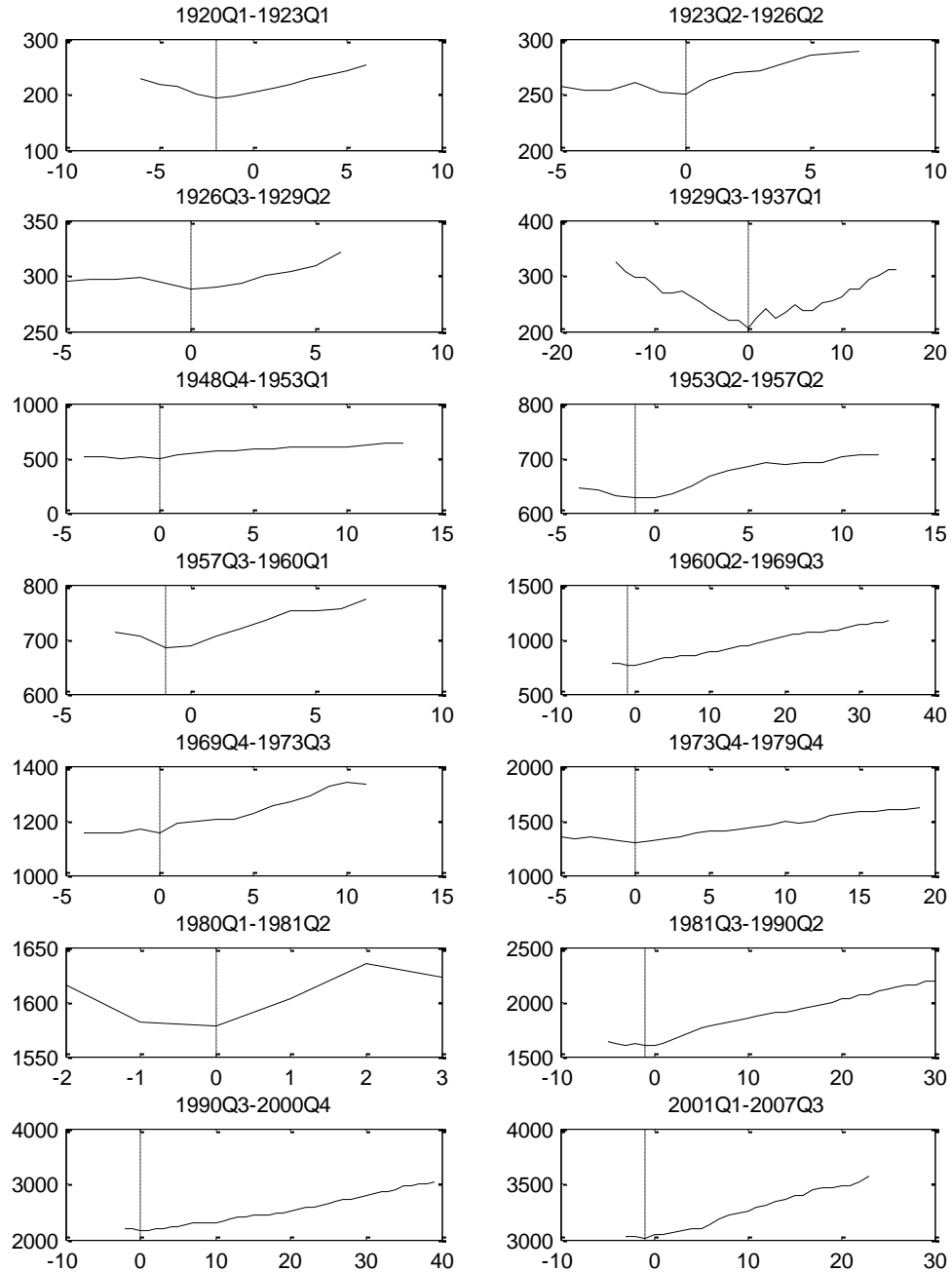


Figure A14: Industrial Production

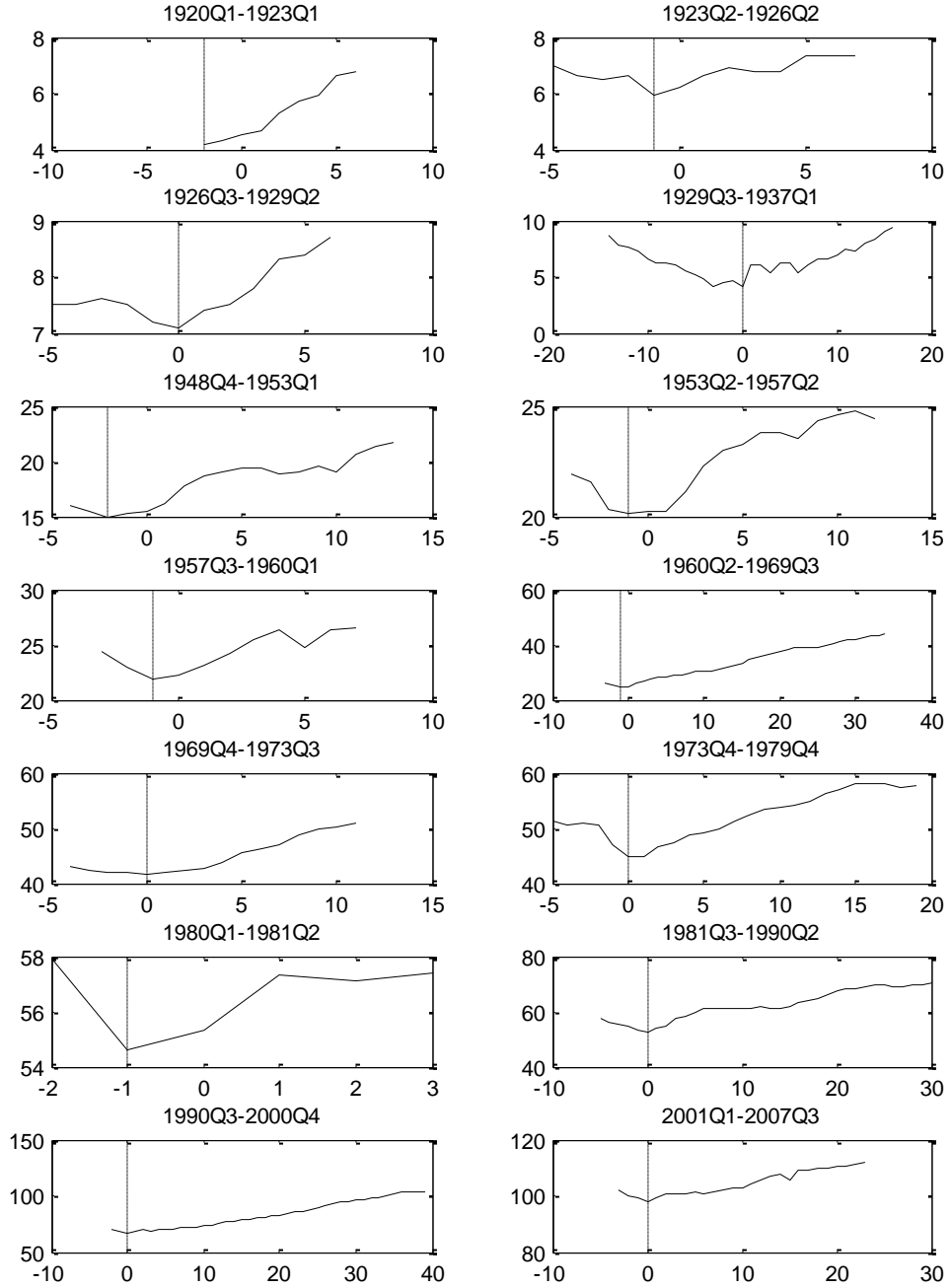


Figure A15: Output Gap

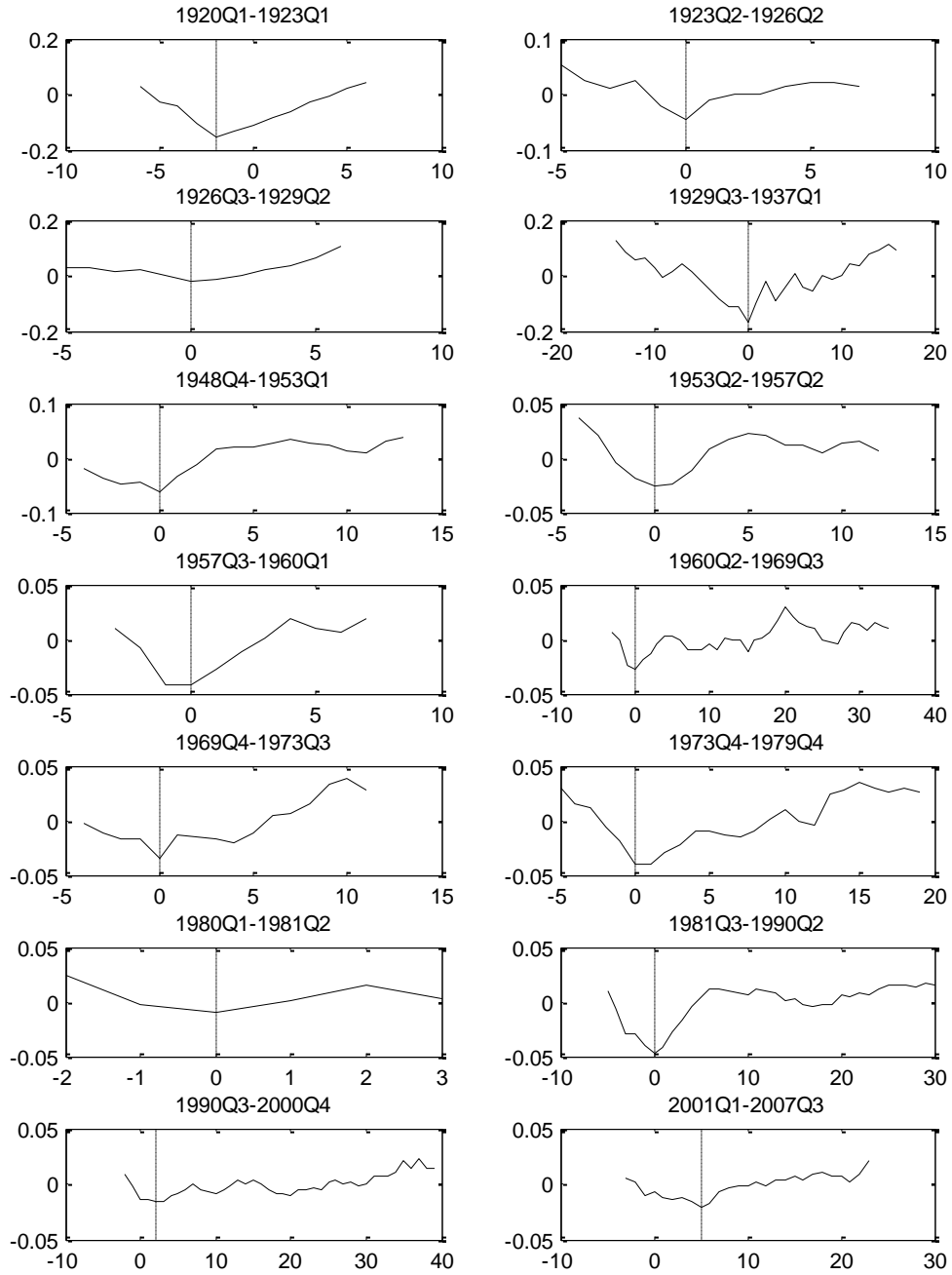


Figure A16: Unemployment

